MINISTRY OF TRANSPORT

# RURAL ROAD MAINTENANCE HANDBOOK

## (For Commune Level)

TRANSPORT PUBLISHING HOUSE
Ha Noi - 2003

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## PREAMBLE BY MINISTER

For many recent years, the transport sector promoted the development programme of rural and mountainous roads on the basis of joint effort between Government and local people. This is a very important programme in terms of socio-economic development. Rural area accounts for 90% of the country area and 80% of the country population. This area has great potential of agriculture, forestry and fishery. This is also a great market of production and consumption and labour resources.

Currently the total length of the local road network is 190,781 km, including 18,344 km of provincial roads, 37,974 km of district roads and 134,463 km of commune roads. Despite of the efforts in rural road development, the road network is still in low standard: only 44% of provincial roads, 15% of district roads and 10% of commune roads are paved with bituminous or concrete surface, and the remaining are gravel or earth roads. The bridge and culvert network on rural roads are in poor condition and some roads are blocked in wet season.

In order to resolve the above problems, it is crucial for the MoT to provide technical guidance and assistance for local authorities in maintenance of roads. This is an important task in addition to the rationalisation of management structure for rural roads, improvement of traffic safety and fund raising. To achieve this objective, MoT published and delivered nationwide the “Rural road maintenance handbook” (for commune level).

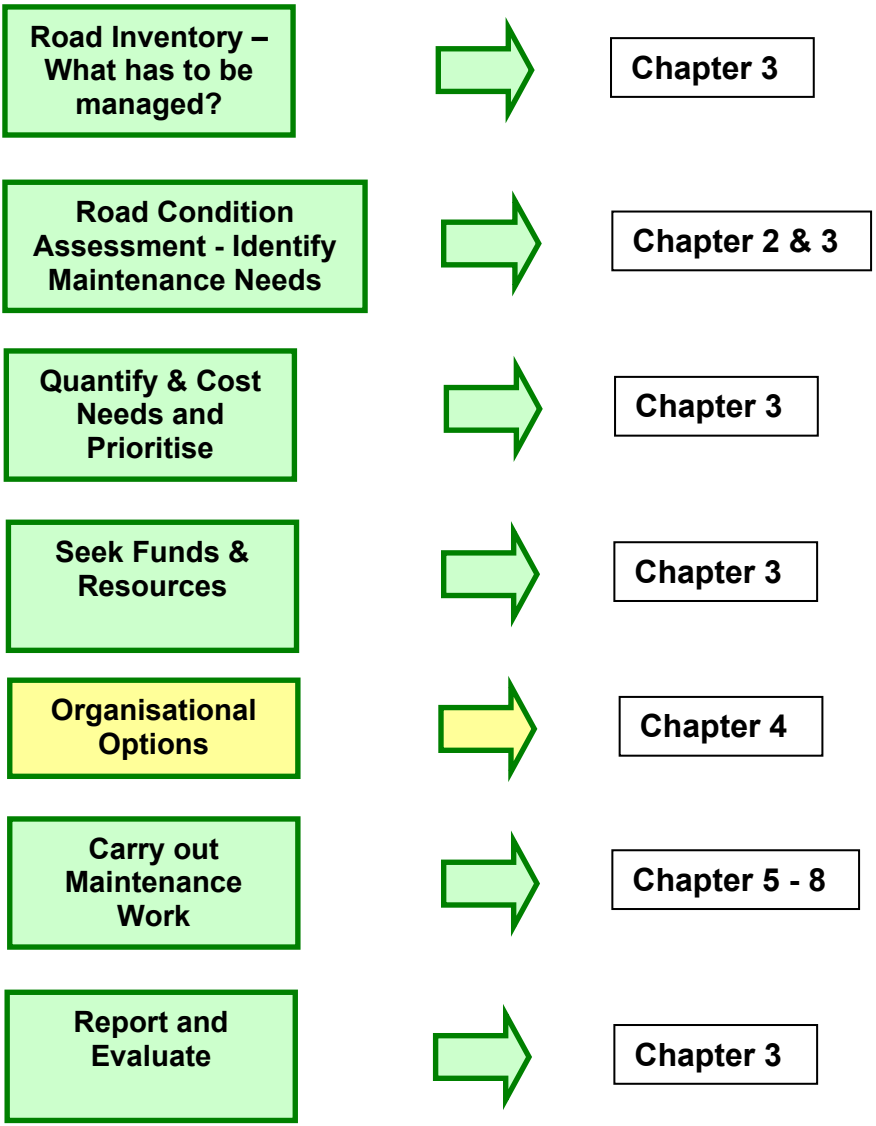
This is an important technical document providing practical and specific guidance for commune staff and people in management and maintenance of rural roads. This will be a useful reference for people working in rural road sub-sector.

I highly appreciate the publishing of the handbook and would like to thank departments of MoT, road specialists, the

donor DFID, WSPI consultant from UK and MoT publishing house who make this handbook possible.

MINISTER
Dr. Dao Dinh Binh

## WHERE TO LOOK IN THIS HANDBOOK



# PART I
# MANAGEMENT WORK

# CHAPTER 1
# IMPORTANCE OF MAINTENANCE.

## I. GOOD MAINTENANCE HELPS TO SAVE SOCIAL WEALTH

All bridge and drainage structures, equipment, plant etc. as well as all components of the road structures need maintenance. It is also important that maintenance is provided in a timely way. If minor defects are repaired promptly, then road service life will be prolonged and the investment will be protected. If the roads are not maintained they will quickly deteriorate and it will be expensive to rehabilitate them. The cost for rehabilitation of 1 km of gravel or stone macadam road in flat terrain is from VND150 to 500 million, whereas the annual cost of routine maintenance is only VND3 to 5 million. In addition, regravelling will cost a long term average of VND6 to 30 million for each year and km of road.

**Planned maintenance involves works to correct minor defects and carry out repairs to the road and road structures to keep them in a condition as close as possible to when constructed. Planned and timely maintenance will minimise the deterioration of the road and help to prevent expensive rehabilitation works.**

According to international and local experiences **if timely maintenance and regravelling are not carried out then roads will be deteriorated after 2 years and could even disappear after 5 years**. Roads can require reconstruction after only 4 years without maintenance.

Vietnamese experience shows that without proper maintenance, rehabilitation costs will be at least 3 times as much in the long term for the community and government. This would waste valuable resources and considerably delay rural development.

Proper road maintenance saves society's wealth. Funding from the central and local government, international organizations, and local people's contributions should be best mobilised for this purpose. In order to achieve this objective, all authorities and sectors must raise their awareness and take actions to develop local maintenance initiatives to match local requirements.

## II. PROPERLY IMPLEMENTING STATE'S ORDINANCE & DOCUMENTS FOR EFFECTIVE MAINTENANCE & MANAGEMENT OF COMMUNE ROADS

There are Ordinance on transport structure protection No. 38L/CTN dated 10 December 1994 of country President (article 15); Decree 172/1999/ND-CP dated 07 December 1999 of Prime Minister providing detailed regulations on implementation of the above Ordinance (article 15); Road Traffic Law dated 12 July 2001 (article 43) relating to the operation, maintenance and protection of transport structures specify that "organisations in charge of transport structures must be responsible for technical condition of structures; timely repair defects that cause hazard to traffic; carry out measures to protect transport structures from natural disaster and be responsible for traffic accidents due to poor condition" (Article 15; Ordinance No. 38L/CTN).

Decree 167/1999/ND-CP regarding management of roads:

- **Article 6, chapter II about road management**: People's Committees of all levels carry out the management function for roads, including:

1. Planning development, local road development in line with local socio-economic and security development and MoT strategy and overall planning of road network.
2. Manage and protect local road network, protect roads passing through the locality as stipulated by the law; coordinate with relevant organisations to agree development plans, and rehabilitation on underground structures where roads are passing.
3. Publicise, educate and inspect the implementation of regulations relating to roads within local jurisdiction.
4. Instruct sectoral organisations in charge of roads to follow legal regulations and professional instructions of MoT.

**- Item 5, Article 8, Chapter III regarding road classification**:

Commune roads (initiated as DX) are roads connecting commune centres to villages or roads connecting commune centres to serve for transport demand within communes.

**- Item 3, Article 11, chapter VI regarding organisation and decentralisation of road management**:

CPCs manage commune roads within communes

**- Article 13, chapter V regarding road investment:**

Road investment includes:

- Investment on new construction, rehabilitation and upgrading of roads.

- Investment on management and maintenance of roads.

The management of road investment is stipulated by current Government regulations.

**- Item 3, Article 14, Chapter V**: Fund for road investment.

Funds for commune road network are mostly mobilised from local people's contribution, commune budget and partly from central support and other sources.

**- Article 15, Chapter V:** Funds for management and maintenance of roads are used for the following items:

1. Management and routine repair (routine maintenance)
2. Periodic maintenance.
3. Emergency maintenance.

# CHAPTER 2
# MAIN FEATURES OF ROADS AND BRIDGES AND CONDITION ASSESSMENT OF ROADS

(These diagrams are not drawn to scale)

## I. TYPICAL CROSS-SECTION OF ROADS

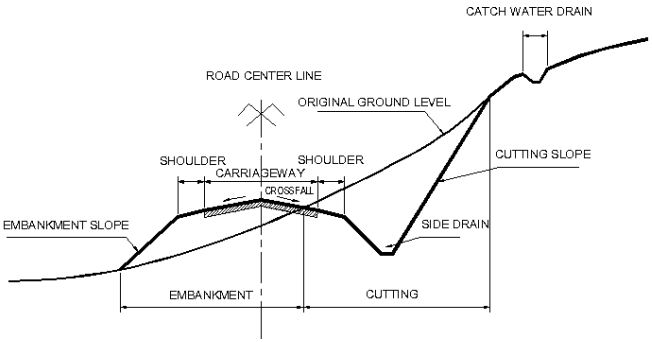



Figure 1

## II. MAIN FEATURES OF CULVERTS

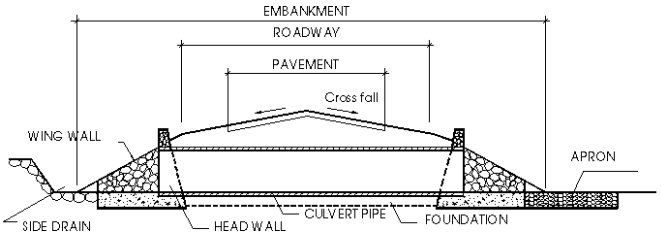



Figure 2

## III. MAIN FEATURES OF BRIDGES

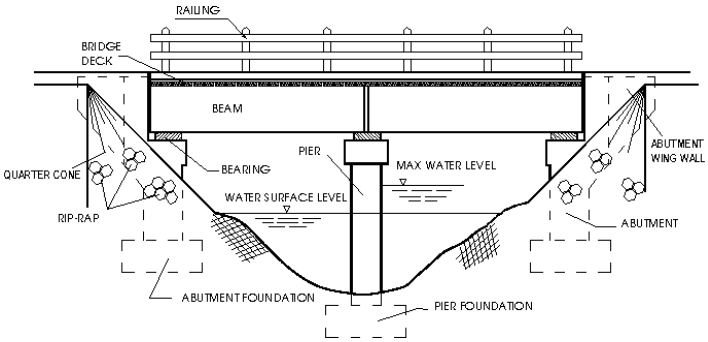



Figure 3

## IV. MAIN FEATURES OF DRAINAGE SYSTEM

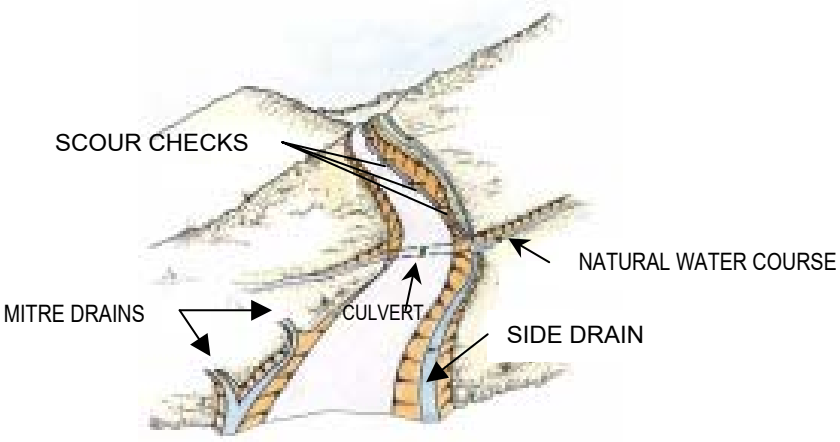



Figure 4


Figure 5 – Road reserve (right of way) of inter village road and inter commune roads is regulated by the PPC

## V. ROAD RESERVATION

The reservation for roads and road facilities are defined in the Government Decree 172/1999/ND-CP.

Road reservation or right of way (ROW) includes reservation on ground, air, underground, water, which is adjacent to the road structure. The ROW helps to prevent any damaging activities against the sustainability of the road structure, to assure safety for road transport, and to protect the road environment. Any temporary or permanent occupations of ROW are considered illegal.

### A. ROW limit for roads:

1. For non-urban roads, based on technical classes of roads, the ROW is determined by the distance from outer edge of filling or cutting embankment or from outer edge of side drain or cut-off drain to both sides outside road area, which is:
   - 10m for class 4 and 5 roads.
   - *ROW for commune and village roads is decided by PPC but not less than roadway width.*
2. For roads running parallel with rivers and canals, which have overlap reservation, the road ROW is defined from higher bank of river towards road.
3. For roads running parallel with railways, which have overlap reservation, the road ROW is regulated by Minister of Transport.

### B. Reservation for bridges, culverts:

- **For bridges outside urban areas:**

The reservation is defined both along the road alignment (a), and perpendicular to the road alignment (b), by:

a. Bridge length, measured from outer extent of abutments:
   - 50m for bridges longer than 60m.
   - 30m for bridges less than 60m.

If the approaching road embankment for the bridge extends beyond the above dimensions, then reservation is extended to the ends of the approaching road embankment.

b. By bridge width, from outer edge of bridge to both sides:
   - 150m for bridges longer than 300m.
   - 100m for bridges from 60m to 300m long.
   - 50m for bridges from 20m to 60m long.
   - 20m for bridges less than 20m.

- **For culverts:** The reservation for a culvert along its length is equal to the reservation of road.

**C. Reservation for dykes, retaining walls, river training works are defined as follows:**

1. For road erosion prevention dykes:
   c. 50m from starting end and ending of dyke toward upper stream and lower stream respectively.
   d. 20m from dyke foot toward river.

2. For river training dykes:
   a. 100m from dyke foot toward upper stream and lower stream respectively.
   b. 50m from dyke foot toward riverbank.
   c. 20m from dyke end toward river.

## VI. CONDITION ASSESSMENT OF ROADS, BRIDGES, AND CULVERTS

It is necessary to carry out an annual quality assessment of the roads and structures, to check condition and decide what maintenance is required in the coming year. The work can then be planned and the necessary resources (funds, labour, materials, equipment) arranged.

In principle, newly constructed roads should not have any defects (good condition). Depending on the surface type and quality, weather and traffic, a road will deteriorate over time. The regular quality assessment should enable appropriate maintenance to be identified and carried out in good time to keep the road in an acceptable condition.

It is appreciated that Commune and District Transport Staff will normally not have access to sophisticated or expensive survey equipment. Also it would be costly and unnecessary to employ surveyors to carry out annual surveys. The recommended condition assessment methods therefore avoid the use of complicated calculations and are based on the use of simple measuring aids:-

- 5 metre tape measure
- Spirit level
- 1 metre and 3 metre hardwood/metal straight edge

For example, measuring the crossfall with simple tools as follows:

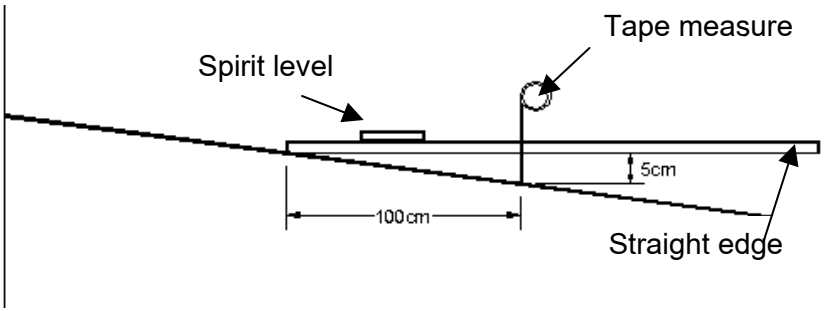



Figure 6 – Checking the crossfall 5%

## VII– CONDITION ASSESSMENT OF DITCHES & SHOULDERS:

It is assumed that shoulders, slopes and drains will be kept in good condition by regular routine labour activities. However, it is important to assess their condition.

Table 1

| 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) |

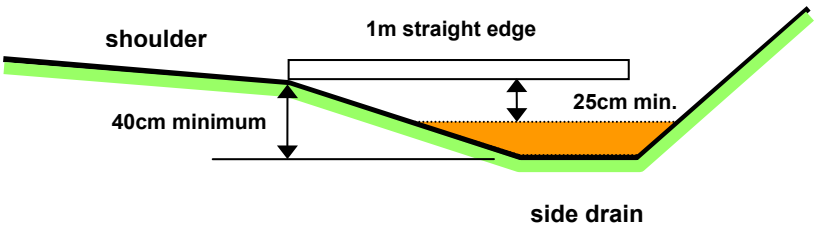
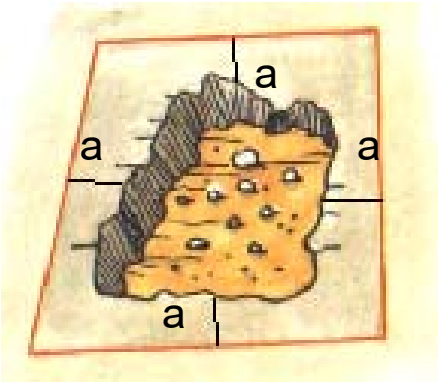



Figure 7 – Checking side ditch

*** Where the road is on embankment, the minimum depth of side drain should be measured down from the surrounding ground level.**

Figure 8 - Mark out and measure area of potholes




a = 5cm

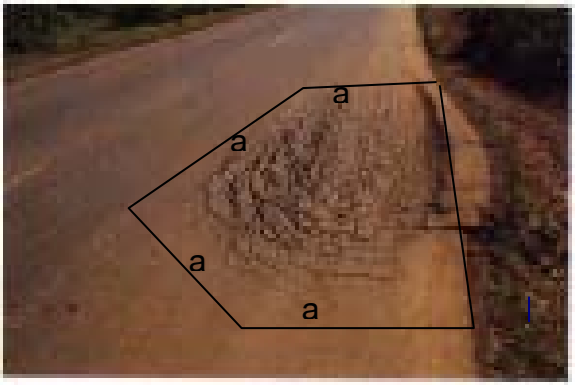



Figure 9 - Mark out area of local depression
a = 5 to 8cm

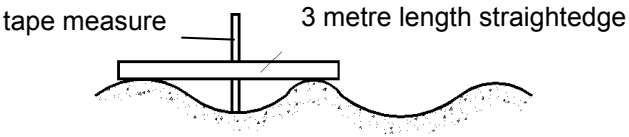



Figure 10 – Measuring the height of corrugation

## VIII- CONDITION ASSESSMENT OF ROAD SURFACE:

### 1. Assessment of earth road:

Table 2 provides quality assessment criteria for an earth road:

Table 2

| 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 |

Methods of assessment

**Crossfall :** Use a straightedge, spirit level and measuring tape to assess the crossfall of the surface every 100metres.

**Pothole**: Mark out pothole areas as shown in the picture (Figure 9); add up the total area of road affected, divide by the total road surface area.

**Corrugation**: Measure height of corrugations as shown in the picture. Make measurement of 5 adjacent corrugations and take the average value for each km of road. Record the total length of road affected by bad and very bad for each criteria.

## 2. Assessment of gravel, laterite or stone macadam roads.

Table 3 provides quality assessment criteria for gravel, laterite or stone macadam road.

Table 3

| 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 |

Methods of assessment: similar to assessment of earth road.

Gravel, laterite or stone macadam surfaces loose material through the action of weather and traffic. It is essential to monitor the material loss and take action to add fresh material in good time. The thickness of gravel should be checked in the wheel tracks at regular (0.5km) intervals along the road by digging through the surface, measuring the residual thickness and carefully reinstating. Note the average gravel thickness.

### 3. Assessment of bitumen or brick road.

Table 4 provides quality assessment criteria for bitumen or brick surfaced road.

Table 4

| 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 |

Methods of assessment for bitumen/brick surfaced road

**Surface Cracking:** Mark out the overall area affected by any type of cracking or surface settlement; Record the total area of road affected. Divide by the total road surface area.

**Potholes**: Mark out areas of pothole, surface damage and edge break as shown in the picture (Figure 9). Record the total area of road affected. Divide by the total road surface area.

## 4. Assessment of cement concrete road

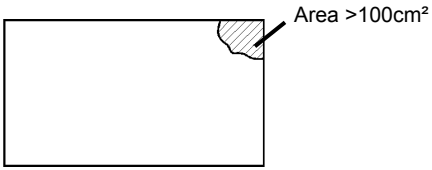
Table 5 provides quality assessment criteria for concrete road.

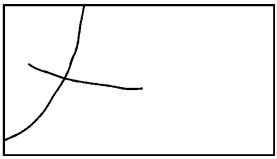
Table 5

| 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 |

Methods of assessment for concrete road:

- Corner breaks: Count number of panels with corner breaks on a road section. Only panels with corner breaks larger than 100cm$^2$ are counted.
- Cracked panels: Count number of panels with cracks on a road section. Only panels with cracks longer than 1metre are counted.
- Individual cracked panels: Of the cracked panels in the previous item, count the number of panels where cracking is greater than 1 metre of cracking per square metre.
- These should be considered for replacement.
- Number of damaged panels divides by total of panels.



A concrete panel is broken at the corner (break area is larger than $100cm^2$)

Total of cracks on a concrete panel (Crack length is longer than 1m)

Figure 11

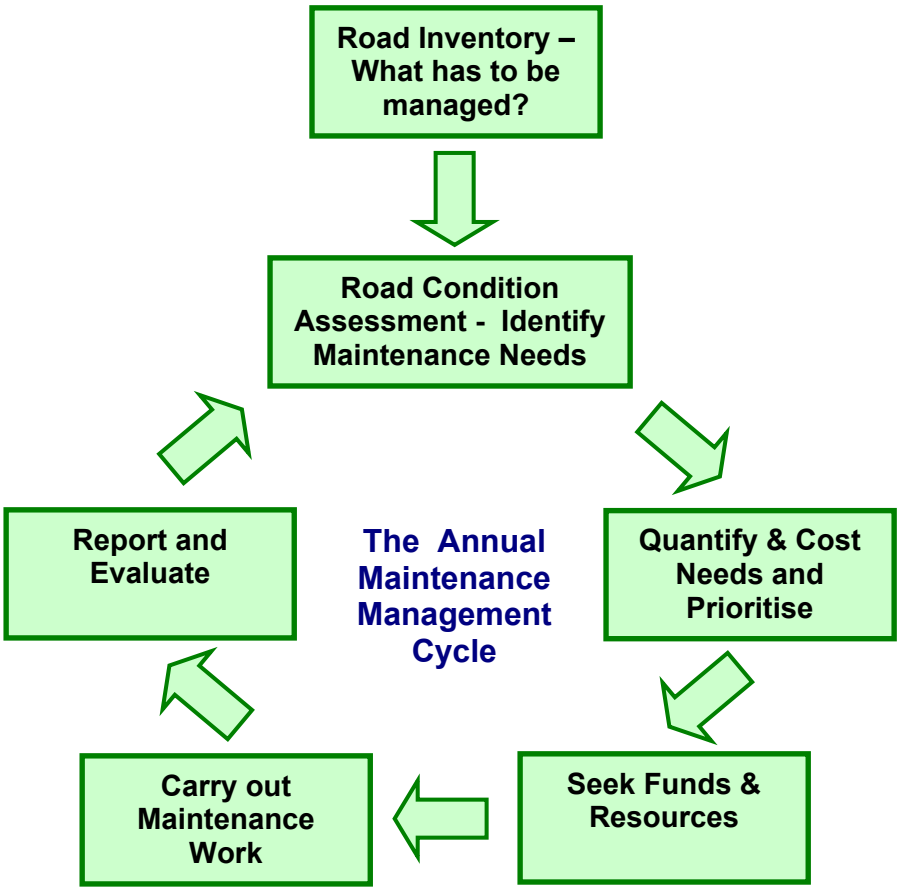
## IX– QUALITY ASSESSMENT OF BRIDGES & CULVERTS

The quality assessment of bridges, culverts and retaining walls requires specialised equipment and skilled personnel for measurement. Communes should cooperate with districts to assess the condition of bridges, culverts and retaining walls.

# CHAPTER 3
# MAINTENANCE PLANNING

## Road Maintenance Management

The diagram below indicates the main activities involved with Road Maintenance Management



## I. PLANNING STEPS OF COMMUNE TRANSPORT STAFF

### Step 1: *establishing Road Inventory record – what has to be managed?:*

Prepare a record of the commune road network that includes:

a. Sketch Plan of the Commune road network: (See example Fig 12).

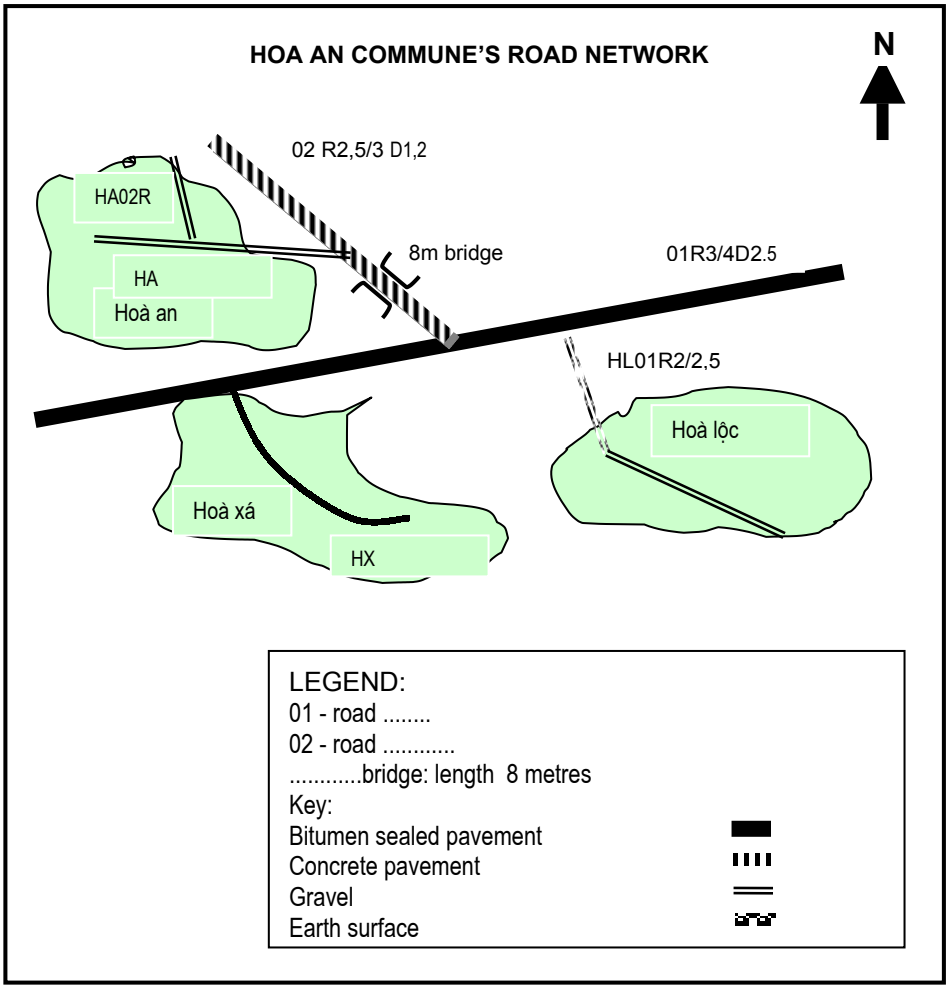
   - Layout of the commune road network and connections to places and other roads. This can indicate important bridges.

b. Inventory Table of all Commune roads and bridges: (See example Table 6 and 7)

   - Important features of the road that help determine the extent and maintenance needs of the road: e.g. road name, code, length, type of surface/pavement, surface width, bridges, culverts, sources of materials.

   The minimum requirements are shown. Communes may have more detailed and useful information available from previous initiatives or projects.

## Figure 12 – Example Road Network Plan




*Note*: Road coding – Using two initials village name or commune name. Followed by order number perhaps from North to South, East to West ... Then pavement width, subgrade width (m) and road length (km). For example: HL01R3,5/5D3 - Hoa Loc village road, code 01, pavement width 3.5m, subgrade width 5m, length 3 km.

**TABLE 6 EXAMPLE FORMAT ROAD INVENTORY TABLE** (*paper size to be A4)*
**COMMUNE:**

| Road Code | Road Name | Road Length (km) | Surface type | Carriage –way (Surface) width (metres) | Number of culverts & bridges < 6m span | Number of bridges span ≥ 6m (separate details) | Sources of materials & distance in km |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**TABLE 7 EXAMPLE FORMAT BRIDGE INVENTORY TABLE (for bridges of span ≥ 6m)**
**COMMUNE:** *(paper size to be A4)*

| Road Code | Road Name | Bridge Location | Date constructed | Constructed by (e.g. contractor) | Deck construction type | Load Limit (tonnes) | Number and length of spans (m) | Remarks e.g. navigation, problems, inspection checklist |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**Step 2.** ***Road Condition Assessment:***

Table 8 is the recommended format for the Field Survey form of the Annual Road Condition Assessment of each road. The form should be completed by the commune under the instruction of District Transport personnel. Refer to the assessment methods in Chapter 2. Table 9 shows an example of the completed form.

One form is to be completed for each road recording:-

- Commune
- Road name
- Road length
- Road Code
- Date of inspection
- For ALL roads the Condition of side drains and vegetation is to be noted.
- The rest of the form is completed according to whether the road is UNSEALED, BITUMEN/BRICK or CONCRETE
- If Gravel, laterite or stone macadam; note the average thickness of residual material in cm as described in Chapter 2.
- Regarding structures (bridges, culverts or retaining walls) if visual inspections show any defects, or if hidden defects such as bed erosion is suspected, or if unusual flooding has been experienced in the previous wet season; then insert the number of structures that need to be inspected (with assistance from the District or Province).

The form allows the important defects to be identified and quantified. Other defects not specifically listed can be noted and quantified at the bottom of the form. The information on

the form can then be used in the next step of the management process, which is to quantify the amount of maintenance work required.

The form should be drawn in A4 format so that there is sufficient space to mark the defects in the km boxes to obtain a visual impression, and identify defect locations as well as to record the quantities.

**Evaluating the Road Condition Assessment**

The completed form will allow the Commune Transport Staff to assess whether:-

- the current Routine Maintenance arrangements are effective (less than a certain percentage of the road with defects)
- additional resources are required for Spot Improvements, Periodic Maintenance or Reconstruction
- bridges or other structures inspections are required
- the gravel, laterite or stone macadam surface thickness requires to be increased under periodic maintenance arrangements

If routine maintenance is shown to be effective, then this will help the justification for additional resources for other maintenance needs.

**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) or landmarks | 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** | | | | | | | | | |
| Surface Crossfall % | | | | | | | | | ***Bad*** |
| (metres of road affected) | | | | | | | | | ***VB*** |
| Potholes (metres of road affected) | | | | | | | | | |
| Corrugations (metres of road affected) | | | | | | | | | |
| | | | | | | | | | |
| 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 (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 | | | | | | | | | |
| Number of structures requiring inspection<br>Culverts:<br>Bridges:<br>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: Hoa Xa** | | | | | | **ROAD: Hoa Xa – Hoa Loc** | | | |
| **ROAD LENGTH: 3.9 km** | | | **Road Code: HA02R3.5/5D3.9** | | | | **Date: 3 – 12 - 2002** | | |
| **Defect and extent of road affected** | | | | | | **TOTAL DEFECTS** | **A =TOTAL DEFECTS / LENGTH OF ROAD (km)** | **% AFFECTED = A/10** | **RATING** |
| Location (km) or landmarks | 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** | | | | | | | | | |
| Surface Crossfall % (metres of road affected) | 800 | 700 | - | 400 | | 1900 | 487 | 49 | *Bad* |
| | - | - | - | - | | - | - | - | *VB* |
| Potholes (metres of road affected) | 10 | 0 | 0 | 2 | | 12 | 3.1 | 0.3 | ✔ |
| Corrugations (metres of road affected) | 200 | 0 | 0 | 300 | | 500 | 128 | 12.8 | *Bad* |
| | 200 | 0 | 0 | 200 | | 400 | 103 | 10.3 | *VB* |
| 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) | | | | | | | | | |
| Potholes (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:

**Step 3.** ***Quantify & Cost the Maintenance Needs***

The quantities of each item of work required can be calculated from measuring the extent of the corresponding defects on the road.

A 'Bill of Quantities' should be prepared to include each item of maintenance work identified as required to be carried out during the coming maintenance year.

The following Table 10 is an example of the suggested format of the Bill of Quantities. The costs should be divided into labour, materials and equipment components.

Actual unit costs can be obtained from local experience or PDOT. The quantities are multiplied by the unit costs to obtain the estimated cost for each item. For Routine Maintenance items the estimate may be for compulsory or voluntary labour days, or a combination of labour and money.

**TABLE 10: EXAMPLE BILL OF QUANTITIES FOR ANNUAL MAINTENANCE PLAN**

| | |
|---|---|
| COMMUNE ……**XXXX** | ROAD NAME ……..….**A TO B** |
| ROAD LENGTH ……**1**…….. KM | ROAD CODE……..**A 123** |
| **SURFACE TYPE** ……GRAVEL | **PLAN FOR YEAR**……2003 |

| **WORK ITEM** | QUANTITY | UNIT COST | **TOTAL** VND | OR NUMBER OF LABOUR |
|---|---|---|---|---|
| **Routine I** | | | | |
| . Control Vegetation: bush/tree clearing & grass cutting, and disposal | 4 worker-day | | | |
| 2. Clean debris/silt from side ditch & turnout drain | 3 worker-day | | | |
| 3. (Re-) excavate side ditch & turnout drain | 200 m | | | |
| 4. Repair erosion in ditches/drains | 50 m | | | |
| 5. Clean debris/silt from culverts & channels (culverts & bridges) | 1 worker-day | | | |
| 6. Fill (and compact) embankment slip | 3 m³ | | | |
| 9. Remove small landslide | 10 m³ | | | |
| 0. Replenish/reshape shoulder surface material | 100 m² | | | |
| 1. Clean road surface (remove debris) | 2 worker-day | | | |
| 2. Clean channel & bridge surface (remove debris) | 1 worker-day | | | |
| 6. Fill potholes (earth and gravel road) | 50 m² | | | |
| 7. Repair Ponding or Soft Spot treatment (earth and gravel oad) | 2 m³ | | | |
| 8. Grade corrugations and reshape camber (earth & gravel oad in labour abundant areas) | | | | |
| 4. Spray water (earth & gravel road) | | | | |

| WORK ITEM | QUANTITY | UNIT COST | TOTAL VND | OR NUMBER OF |
|---|---|---|---|---|
| **Routine II - Responsive**<br>20. Grade corrugations & reshape camber (earth & gravel road by equipment in low population areas)<br>26. Paint & repair traffic signs & repair guard rail<br>27. Fill pothole (bitumen road)<br>28. Seal individual or intersecting cracks (paved road)<br>29. Treat soft spot or rut(bitumen road) | | | | |
| **SUMMARIES** | | | | |
| **ROUTINE MAINTENANCE I - TOTAL ANNUAL COST**<br>**TOTAL LABOUR-DAYS** | | | | |
| **ROUTINE II - RESPONSIVE MAINTENANCE** | | | | |
| **PERIODIC MAINTENANCE (Prepare separate detailed estimate)** | | | | |
| **EMERGENCY MAINTENANCE – CONTINGENCY** | | | | |
| **SPOT IMPROVEMENTS (Prepare separate detailed estimate)** | | | | |
| **TOTALS** | | | | |

**Step 4.** ***Match programme to resources available***

**Calculate amounts of resources expected for maintenance:**

*For example:*

Cash specifically for maintenance:

| | |
|---|---|
| - Commune Budget: | 1,500,000 VND |
| - District Budget's Support | 700,000 VND |
| - People's cash contribution (50,000 VND per person) | 2,800,000 VND |
| - Road Fund | 2,000,000 VND |
| | 7,000,000 VND |

Compulsory and voluntary labour for maintenance (instead of cash)

| | |
|---|---|
| - 220 labour days equivalent to | 2,200,000 VND |

**Total equivalent resources maintenance budget** ***9,200,000 VND***

The Maintenance Plan will need to adjusted if the amount of budget is less than the amount required to carry out all of the maintenance works identified as required. Improvement and Periodic Maintenance items should be reduced if there are insufficient funds. Routine Maintenance is the highest priority to be retained in the Plan.

When the actual funds available for maintenance are known then a further adjustment of the Maintenance Plan will be required.

Commune authorities should consider whether additional funds or resources could be raised locally to meet any shortfall.

Details of the work that cannot be included in the Maintenance Plan due to shortage of funds or resources should be notified to the District Transport Staff. It may be possible to seek additional funding or support. Otherwise, work may have to be carried over until it may be considered for inclusion in the following year's Maintenance Plan.

**Step 5. Implementation**

When the funds and resources are approved, the maintenance works may be arranged using the selected organizational option (refer to Chapter 4) and the appropriate maintenance techniques (Chapter 5).

**Step 6. Monitoring the plan implementation**

The Commune Transport Staff should ensure that the planned work is completed to a satisfactory standard. This includes checking the quantities of each item of works completed against the Maintenance Plans. The quality of the work is also important and should be methodically checked.

**Step 7. Reporting**

When the year's maintenance works have been carried out, a simple report should be completed by the Commune Transport Staff; a copy to be forwarded to the District. The report should summarise the work carried out, detail any uncompleted or carried over work, and note any problems or

concerns. This report should be available ready for the next Annual Road Condition Assessment.

## II. Funding Options

*In order to select a suitable maintenance option, the commune level firstly needs to find resources for maintenance. Within current budget constraints for maintenance of rural roads, there are some initiatives that may be used to create a budget for maintenance. Below are some typical options:*

1. Significant available resources from compulsory and volunteer labour:

Communes use compulsory and volunteer labour for transport, irrigation, construction and education works etc. Level of mobilization depends on the annual requirement of each sector. It is possible to extract resources from these labour contributions for maintenance of rural roads.

2. Communes can increase funds for maintenance.

CPCs can provide some funds for buying materials to repair roads. It means that it is quite possible to gain access to the commune budget for maintenance works.

3. People are willing to support initiatives from local authorities

Once people are involved in discussions and well informed about the purposes and the use of contributions then they may be willing to support. For example in Ninh Binh in 2000, apart from compulsory labour, local people contributed about

27.7 billion VND in different rural road programmes. In Ha Tinh, apart from compulsory labour, some communes can mobilise a further 3 to 5 man days per person.

4. Collecting road tolls from commercial vehicles. The typical toll for each “Cong nong” is 500,000 VND/each/year.

5. A separate fund for road maintenance may be set up at commune level from district budget and various sources.

6. Other options: Many provinces have taken initiatives for creating funds. For example, some PPCs decided to provide funds for maintenance of rural roads upgraded by projects.

Above are some typical examples of fund mobilization. In practice there may be other initiatives by provinces depending on local condition.

When preparing annual maintenance plans, authorities at all levels should identify which administrative level will fund maintenance; are there sufficient funds for maintenance of roads within their jurisdiction? Priorities for routes and activities on road maintenance within limited fund should also be identified.

It is very important for the PPCs and PDOTs to aware about the importance of road maintenance. There should be a balance between capital and recurrent budget. If investment is only focused on new construction and rehabilitation then social resources will be wasted.

Figure 13 – Rural roads maintained by contractors

Figure 14 – Rural road maintained by force account

# Chapter 4
# MAINTENANCE ORGANISATION MODELS. RESPONSIBILITIES OF MAINTENANCE OFFICERS

## I. MAINTENANCE ORGANISATION MODELS:

There will be a number of organizational options suitable for rural road maintenance work, depending on the level of funding allocated. In the current situation the funds available for routine maintenance in most localities nationwide is very limited. The majority of the funds come from compulsory labour or the cash or goods equivalent.

However, many localities have taken initiatives in maintenance organisation with limited fund resources. This experience is valuable.

For example, the model of family contract where the payment is made through compulsory labour or by paddy rice from compulsory labour and the commune budget. This arrangement has been shown to be suitable for Routine maintenance.

It is possible to arrange a contract or agreement with households or a group in the local community. Periodic maintenance is often arranged by force account e.g. district maintenance teams.

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 as well as appropriate conditions to be applied. 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 delta 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.

There are some examples of maintenance organisation options operating in various localities as follows:

- **Ninh Binh**: In Yen Loc commune, Kim Son district, the chairman of CPC signed contracts with 3 householders to do routine maintenance of commune and village roads. Each household had a contract to maintain 1.5 km of road with a payment of 300 kg of paddy rice per year. The current market value was VND 1.500 per kg, the value of 300 kg of paddy rice was VND 450 thousand. So the routine maintenance cost for 1 km of road per year was the equivalent of VND 300 thousand.
- **Bac Lieu** : districts in Bac Lieu have a "volunteer programme". In some communes there are some households maintaining sections of road, e.g. a section of 7 km maintained by 4 households, using compulsory labour.

- **Ha Tinh**: village roads are managed by village authorities.
- **Lai Chau**: An Agriculture team is responsible for the maintenance of some commune roads.
- **Bac Lieu** PDOT submitted a proposal to and gained approval from PPC to set up Transport "Hat"s that are responsible for maintenance of district and commune roads. The funds for those "Hats" are mobilized from provincial budget.
- Some provinces would like to establish District maintenance teams.

Each locality should find an appropriate option for their circumstances.

In Annex 2 there is a sample of a contract between CPC and a representative from the local community on implementation of maintenance work. This model is specifically applied for some routes, including maintenance items, and timing for maintenance. The commune provides the initial tools.

Depending on the availability of resources including mandays, cash or paddy, each locality can adjust contract terms related to responsibilities for maintenance items and payment method.

Following are analyses of each rural road maintenance organization option.

## OPTION 1 – Large Contractor

### DESCRIPTION

The use of large, medium and small enterprises is stipulated in the Government's Decree 90/2001/ND-CP. The distinction between this option and Option 2 is that the enterprise is expected to own or hire heavy construction equipment for road works.
This implementation option can be particularly suitable for Emergency and Periodic Maintenance activities

### ADVANTAGES:

- Experience of the enterprise
- Available range of equipment and skills.
- Speed of implementation

### DISADVANTAGES:

- High overheads
- High mobilization and demobilization costs
- Lack of commitment to the community
- Time, resources and costs involved with preparing contract
- Large contractors may not be interested in the smaller scale of maintenance contract works
- Market for maintenance works currently not developed
- Few prospects for local employment and money being injected into the commune
- Insufficient funds currently available to pay for this approach.

## OPTION 2 – Small Contractor (Private)

**DESCRIPTION:**
The use of small enterprises is stipulated in the Government Decree No 90/2001/ND-CP. The distinction between this option and Option 1 is that small enterprises only own or hire a limited amount of equipment for implementing roadwork. They would be expected particularly to make use of light equipment and local labour.

**ADVANTAGES**:

- Overheads lower than Option 1
- Low mobilisation and demobilisation costs
- Experience of the enterprise
- Available range of skills
- Local enterprise committed to the community
- Good prospects for local employment and money being injected into the commune

**DISADVANTAGES:**

- Time, resources and costs involved with preparing contract
- Market for maintenance works currently not developed
- Small contractor may have to hire in some equipment
- May initially require some training/ mentoring, or a higher level of supervision than large contractors
- May have difficulty in obtaining credit, or financing cash flow
- Insufficient funds currently available to pay for this approach

## OPTION 3 – Force Account

**DESCRIPTION:**
The use of a permanently employed and equipped workforce to carry out the maintenance work such as regional road management units and district road maintenance teams. This implementation option can be suitable for All Maintenance activities.

**ADVANTAGES:**
- Direct response to all maintenance needs
- Rapid mobilization when funds are available
- Retain skills and experience within organisation, familiarity with the network, standards
- Dealings/ disputes with outside parties minimized.

**DISADVANTAGES:**
- In some cases no budget or funds currently available for this option
- Difficulties in equipment procurement & the lowest cost policy can hinder the standardization and efficiency.
- Low efficiency and poor management/use of available resources, poor cost-awareness
- Little pressure to try new solutions/ technologies
- High mobilization and demobilization costs from provincial level

## OPTION 4 – Community Group

**DESCRIPTION:**
The use of a group of persons based within the community and organised specifically to carry out the maintenance works under an agreement or contract with the commune authority. This approach differs from the Length person or Family contract approach only in that the number of persons expected to be involved would be greater, and that consequently work would probably be concentrated at a particular time or times of the year. This implementation option can be particularly suitable for Routine Maintenance activities

**ADVANTAGES:**

- Low cost compared to most other forms of contract (due to low overheads, absence of profit component, and by local participation)
- Can be cash or in-kind payment according to commune circumstances
- Simple contract/agreement required
- Direct response to routine maintenance needs - Rapid mobilization
- Retain skills and experience within the commune, familiarity with the network
- Close control of the works personnel
- Pride of 'ownership' for the network
- No dealings/disputes with parties outside of the commune
- Employment and money/resources recycled within the commune
- Employment can be targeted at poor or disadvantaged in the commune.

**DISADVANTAGES:**

- Possibly insufficient cash funds available to pay for this approach in poor communes
- Possible difficulties in controlling output and quality
- Not suitable in areas of dispersed or low population density.


Figure 15 – Private enterprises involved in maintenance

## OPTION 5 – Length Person or Family Contract

**DESCRIPTION:**
A contract or agreement is drawn up for an individual or family to carry out specified routine maintenance activities on a section of road, at certain times of the year, for a payment in cash or in-kind for work on a full or part time basis.

**ADVANTAGES:**
- Low cost compared to most other forms of contract (due to low overheads, absence of profit component, and by local participation)
- Can be cash or in-kind payment according to commune circumstances. Simple contract/agreement required
- Direct response to routine maintenance needs. Rapid mobilisation
- Close control of the works personnel
- Pride of 'ownership' for the network
- No dealings/disputes with parties outside of the commune
- Employment and money/resources recycled within the commune
- Employment can be targeted at poor or disadvantaged in the commune

**DISADVANTAGES:**
- Possibly insufficient cash funds available to pay for this approach in poor communes
- Possible difficulties in controlling output and quality
- Not suitable in areas of dispersed or low population density.

## OPTION 6 – Compulsory/Voluntary Labour

### DESCRIPTION:

The use of local (commune) labour to carry out maintenance works on the roads as part of the legal requirement to provide free labour for community purposes. This can be augmented by additional voluntary labour contributions. The approach can be suitable for Routine Maintenance activities. Currently used for emergency work.

### ADVANTAGES:

- No financing or cash accounting involved
- In richer communities, individuals can elect to pay cash instead. This can provide funding for materials and equipment hire, or even paid labour
- Direct response to all maintenance needs
- Rapid mobilization
- Retain skills & experience within commune and family
- Direct control of works personnel
- Pride of 'ownership' for the network
- No dealings/disputes with outside parties

### DISADVANTAGES:

- All persons contribute equally, whether rich or poor
- Can be a severe burden on the community's poorest persons
- Difficulties in controlling output and quality
- Not suitable for work during the agricultural 'high' season
- Not suitable in areas of dispersed or low population density

- Few prospects for PAID commune employment or money being injected into the commune


Figure 16 – Commune maintenance team involved in maintenance

## II - ROLES AND RESPONSIBILITIES OF MAINTENANCE OFFICERS OF PROVINCE, DISTRICT AND COMMUNE LEVELS

**The PDoT Maintenance Officer will:**

- Manage data related to maintenance of the province's rural road network, including data on road network condition and existing situation of maintenance in districts and communes.
- Assess the needs for training programmes to provide support for budgeting/cost estimating, planning (including prioritization policy), management (including management information), monitor and report on the quality and funding for maintenance done by Districts and Communes.
- Take action to support each District's work on maintenance and facilitate access to local resources for gaining knowledge, capacity building, access to advice and training.
- Prepare an annual report for the province on the condition of the rural road network, funding and resources used, and quantity and quality of maintenance work.

**The District Maintenance Officer will:**

- Manage the maintenance activities for any rural roads, which are the responsibility of the District.
- Carry out annual surveys of road network condition for District and Commune roads and report annually on the quantity and quality of maintenance work and resources used in Districts and Communes.

- Support the Commune Maintenance Officers to develop their skills and capacity to manage and implement maintenance work in their Commune, where necessary coordinating provision of support from training and capacity building.
- Monitor regularly the work on maintenance in Communes and Villages.
- Request special assistance or advice from Provincial authorities when required.

**The Commune Maintenance Officer will:**

- Manage the maintenance activities for any rural roads, which are the responsibility of the Commune.
- Supervise the maintenance works on a daily basis when they are being carried out, and ensure that the quantities of work planned are carried out to the required quality standards in a timely way, using the agreed implementation options.
- Collaborate with the District Maintenance Officer on surveys of the road network.
- Make requests to the District Maintenance Officer for support including training.
- Report to the District on an annual basis the maintenance works achieved, the condition of the roads, and plans for future maintenance.

# PART II
# MAINTENANCE WORK

# CHAPTER 5
# ROUTINE MAINTENANCE TECHNIQUES

This chapter describes how to carry out the regular maintenance of commune roads principally using labour methods, to minimise transport problems for the community. It is written specifically for the persons responsible for organizing and carrying out the regular **ROUTINE MAINTENANCE**.

There are some maintenance items that require only unskilled labour and simple handtools 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 specialised skills such as pothole patching, or mechanical grading. They require certain additional resources and specialised skills. These maintenance items are called **Routine 2.**

**PLANNED and timely routine maintenance will minimise the deterioration of the road and help to prevent expensive rehabilitation works:-**

***"Defects must be repaired – if ignored the costs will be at least doubled"***

This chapter describes the common defects found on the road surface, structures, adjoining land and drainage system, and how to repair them and prevent serious

damage.

If maintenance is not carried out, a road will deteriorate very quickly and may become impassable. Transport of community people and goods will be affected. It would also cost the community much more to rebuild a deteriorated road than to regularly maintain it properly (over 3 times as much over a period of time).

It is important to keep in mind that: **Water is the main enemy of roads**. All efforts must be made to let rainwater drain off the road as quickly as possible. Water must not be allowed to stand on or near the road surface.

The other enemy is heavy or overloaded vehicles, which can severely damage weak roads. The commune should restrict access by heavy vehicles unless the road is specifically designed to carry them.

# I. WATER IS THE MAIN ENEMY OF ROADS

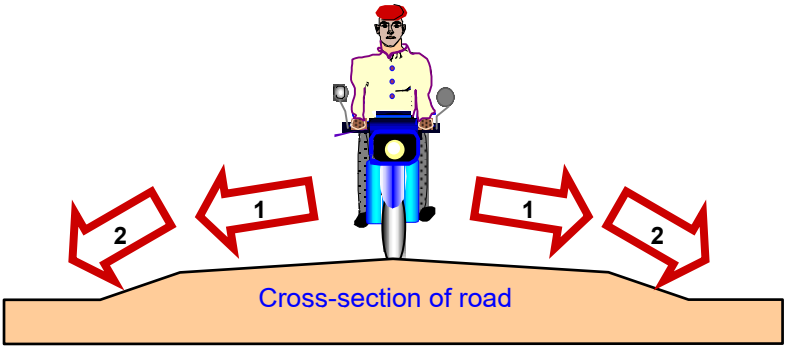
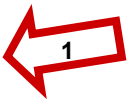



Figure 17

**Drainage of the road to ensure year-round access must be achieved by 2 key features: -**




**maintaining cross fall (camber) to drain rain water off the road,**

**and**


**ensuring that rain water flows from the edge of the road surface (the shoulder) into side drains, or down the embankment slopes, and away from the road.**

**If these features do not exist now, then they should be provided as soon as possible.**

## II - ROAD FEATURES

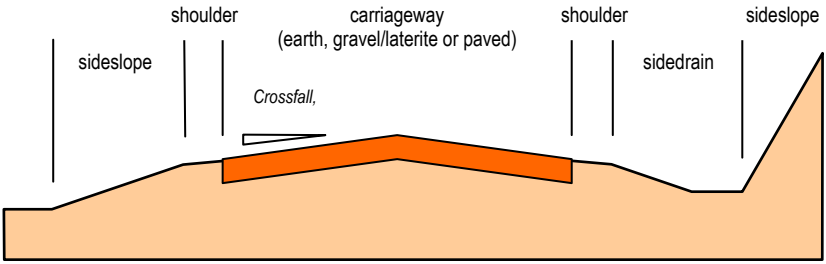



Figure 18

## III - DRAINAGE FEATURES

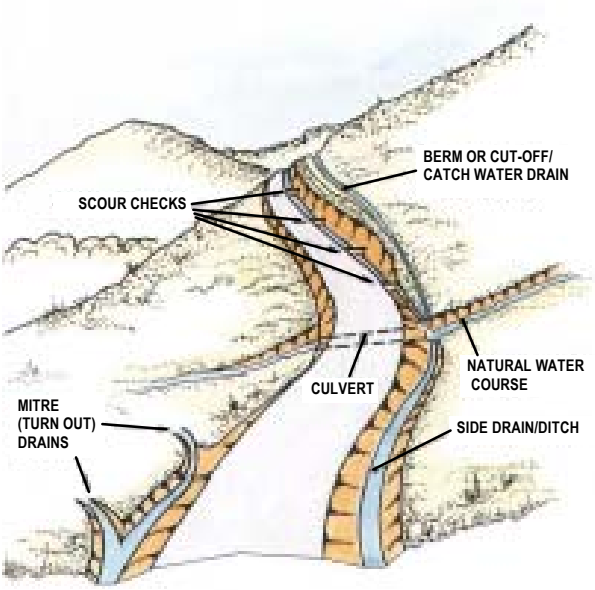



Figure 19

## IV – TERMINOLOGY USED IN CHAPTER 5

1. **Shoulder** The area between the edge of the road surface and the side drain or side slope. Its purpose is to support the edge of the road.

2. **Compact and compaction:**

Compaction in maintenance is carried out to compress a material and make it stronger. Compaction is achieved by:

- Machine compactor such as jumping compactor, vibrating plate compactor of 100-200kg (see annex 5) or roller.
- Manually such as cast iron rammer or wooden rammer of 20-30kg. Whatever compaction method is used, an overlap of 1/3 of compaction footprint must be provided between compactions and compaction must be done from the edge to the centre of patching or road.

Proper compaction is achieved when no compaction marks are no longer seen on the surface.

3. **Appropriate moisture content for compaction:**

Soil, gravel or laterite material should be slightly damp for placing and compacting in the road surface. Checking may be done as follows:

- Squeeze material in the hand. If the material is damp enough to stick together, it is suitable for use. If water runs out of the material, it is too wet and should not be

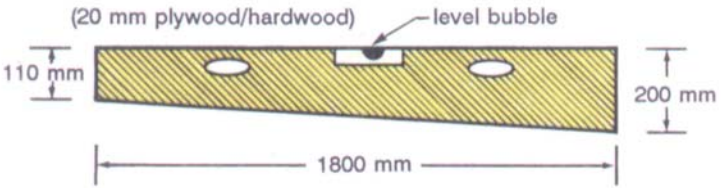
used. If the material falls apart on opening the hand it may be too dry.

**4. Cross fall (camber)**

The slope of the road surface from the middle of the road to the edge to shed rain water quickly. Cross fall should be from 4% to 6% for earth, gravel or stone macadam roads (1 cm drop every 17 – 25cm). For paved roads the cross fall should be 2% – 3% (1cm drop every 33 – 50cm).

*Example: A gravel road is 3.5metres wide. Half width is 1.75m, then the central point should be at least 7cm higher than road edge (1.75m x 0.04 = 0.07m).*

Crossfall can be measured by a template as shown in the picture, or by straight edge, spirit level and measuring tape.




***5% Crossfall template***

Figure 20

## 5. Crossfall of shoulder:

Crossfall of shoulder is adjacent to crossfall of road. Shoulder crossfall should be steeper than road crossfall for best drainage. Shoulder crossfall is normally from 4% to 6%. The most important maintenance activity is to maintain proper profile and crossfall of road and shoulder because water is the first enemy of roads. The assurance of crossfall of road and shoulder will help to prevent defects such as potholes, depression and soft spots.

## 6. Subgrade:

This is the prepared soil foundation which forms the running surface for an earth road or the surface on which the gravel or paving materials are constructed.

# V. THE ROUTINE MAINTENANCE ACTIVITIES

## ROUTINE 1

| | | |
|---|---|---|
| **Vegetation** | ❑ | **Control Vegetation: bush/tree clearing & grass cutting, and disposal** |
| **Drainage** | ❑ | **Clean debris/silt from side ditch & turnout drain** |
| | ❑ | **(Re-) excavate side ditch & turnout drain** |
| | ❑ | **Repair erosion in ditches/drains** |
| | ❑ | **Clean debris/silt from culverts & channels (culverts & bridges)** |
| **Earthworks** | ❑ | **Refill embankment slip** |
| | ❑ | **Refill slope gully** |
| | ❑ | **Repair waterway scour** |
| | ❑ | **Remove small landslide** |
| **Shoulder** | ❑ | **Reshape/replenish shoulder surface material** |
| **Cleaning** | ❑ | **Clean road or bridge surface and opening (remove debris)** |
| **Dust control** | ❑ | **Spray water (earth & gravel road)** |
| **Road signs** | ❑ | **Clean road signs** |
| **Road Surface** | ❑ | **Fill potholes (earth, gravel, stone macadam, brick road)** |
| | ❑ | **Repair Ponding or Soft Spot treatment (earth and gravel road)** |
| | ❑ | **Grade corrugations** |
| | ❑ | **Reshape camber (earth & gravel road in labour abundant areas)** |
| **Structures** Inspection | ❑ | **Check for visual defects** **(See page 96)** |

## ROUTINE 2 (may require outside assistance)

| | | |
|---|---|---|
| **Road Surface** | ❑ | **Reshape road camber (by equipment)** |
| **Structures and culverts** | ❑ | **Repair or replace bridge nails** |
| | ❑ | **Replace bridge wooden planks** |
| | ❑ | **Repair bridge quarter cone** |
| | ❑ | **Repair apron** |
| | ❑ | **Repair retaining wall** |

**The following skilled tasks may require outside assistance and are not described in this Handbook – consult with District Transport personnel.**

| | | |
|---|---|---|
| **Furniture** | ❑ | **Paint and repair traffic signs or guard rail** |
| **Bitumen road** | ❑ | **Fill pothole (bitumen road)** |
| | ❑ | **Seal individual or intersecting cracks (bitumen road)** |
| | ❑ | **Treat soft spots or ruts (bitumen road)** |
| **Concrete road** | ❑ | **Repair concrete slabs - Corner break on concrete slab, crack on surface and damaged joint material.** |

## VI – MINOR DEFECTS AND ROUTINE MAINTENANCE ACTIVITIES

### ROUTINE MAINTENANCE 1

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

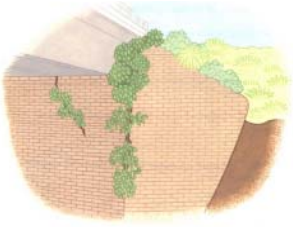


Figure 21

**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).

Figure 22

- 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.

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

Figure 23

**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.

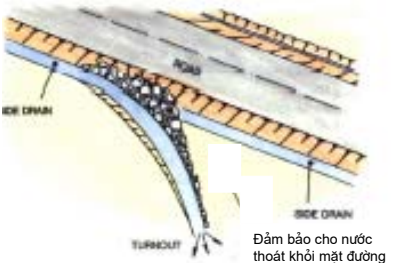



Figure 24

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

**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.

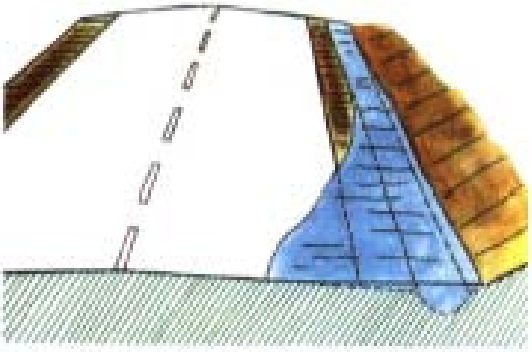


Figure 25

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

Different shapes of side and turn-out drains

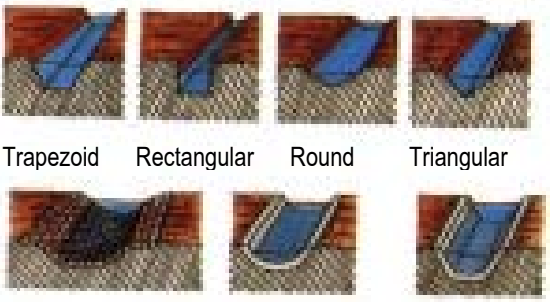



Figure 26
Drain lining options

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.*

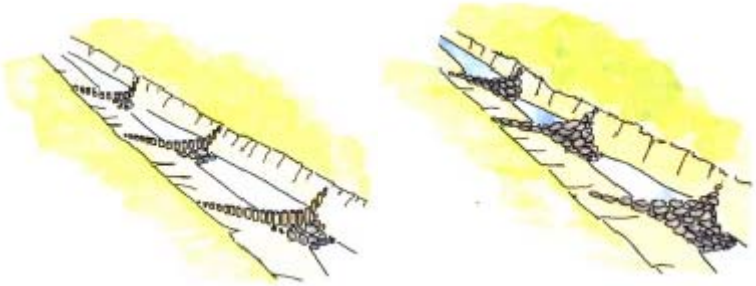


*Figure 27 Scour checks reduce water velocity on steep drains to prevent erosion.*

- 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.

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

Figure 28

**Maintenance activity 5 – Clean debris/silt from culverts.**

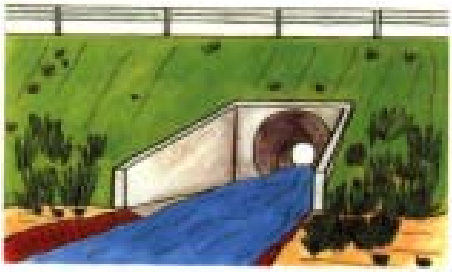


Figure 29

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.

**Defect 6 – Slip on embankment**

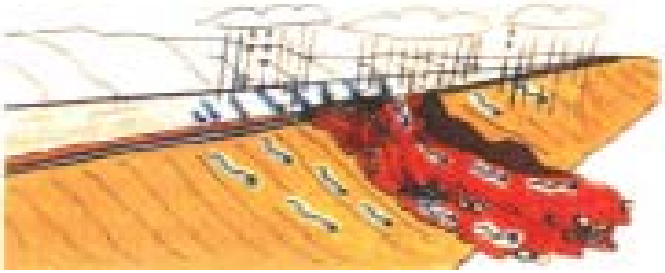


Figure 30

**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

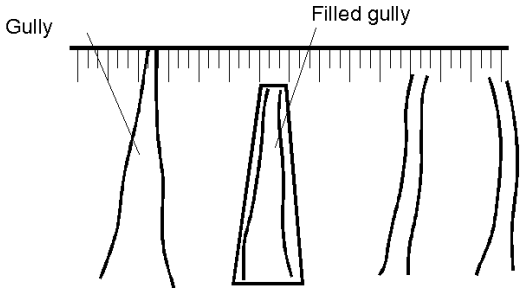



*Figure 31 Filling gullies on fill slope*

## 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 8 –** Embankment toe scoured by waterway or water traffic. This defect is a common occurrence in Mekong delta and in low-lying land in Red River delta.

**Maintenance activity 8 – Repair waterway scour**

- Firstly check the depth of erosion at embankment toe to prepare soil for filling. Filling soil is soft clay or sand-clay mix. That means it can be cut into pieces by spades.
- Prepare bamboo piles. In Red River delta, it is best to use thick-flesh bamboo. Pile length is 2 to 3m. 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

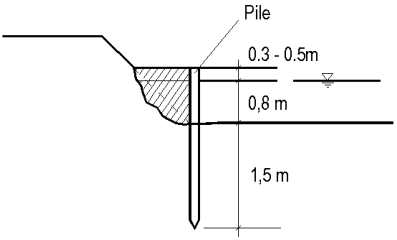



*Figure 32 Repair erosion at embankment toe caused by river traffic*

**Defect 9 –** Minor landslide on to the road

Figure 33

**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

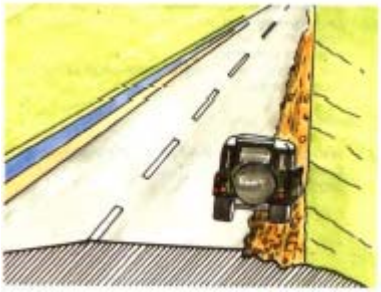


Figure 34

**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.

Figure 35

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.

Figure 36

**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.

Figure 37

**Maintenance activity 12 – Clean channel & bridge surfaces**

Clean bridge surfaces, clear all bridge drains.

Figure 38

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

Figure 39

**Maintenance activity 13 – Clear bridge or causeway opening**

Remove logs and other obstructions from channel.

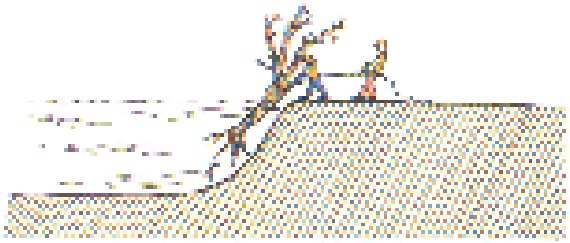


Figure 40

**Defect 14** – Dry and dusty surface

Figure 41

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**

Figure 42

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**


Figure 43

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

Figure 44

**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

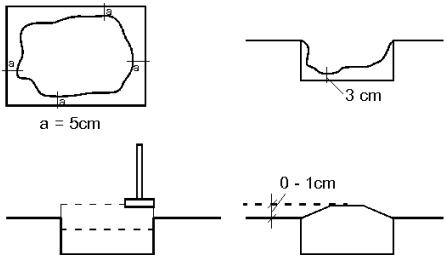



*Figure 45 Pothole filling on earth and gravel road*

**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.

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

Figure 46

**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 (see Terminology Item 3). Build up in 10cm layers, compact each layer before laying the next.
- Resurface the road and compact.

**Defect 18 -** Road surface corrugated – unpaved road

Figure 47

**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. cong nong, tractor or bulldozer.

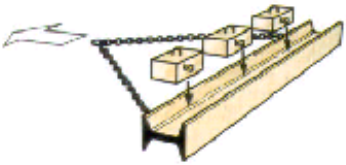


*Figure 48 Steel* I *beam (400mm depth section) drag. Can be surcharged to increase weight if necessary*

*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.

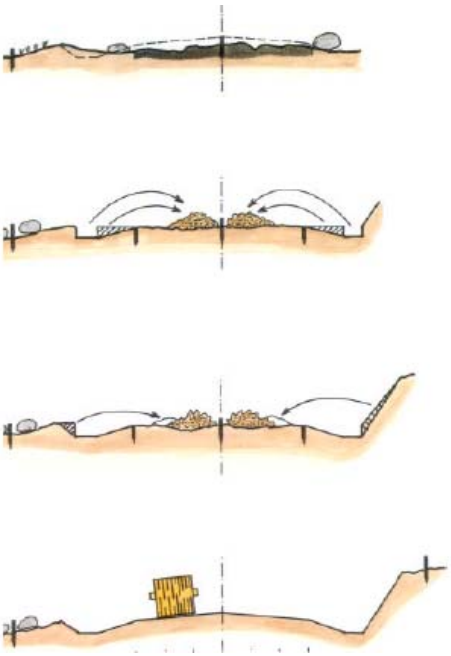


Figure 50

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


*Figure 51 - Restore camber*

## ROUTINE MAINTENANCE II

These activities may require skills, materials or equipment to be brought in.

**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.

Figure 52

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.

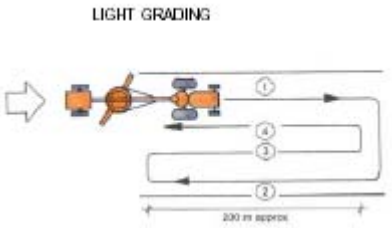



Figure 53

- 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.

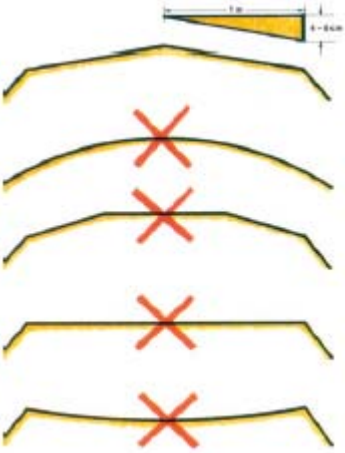


Figure 54

**Defect 21** - Loose nails or missing nails on wooden bridge

**Maintenance activity 21 - Renail or replace bridge nails**

The correct nails should be used and their heads should be driven to final position below the surface.

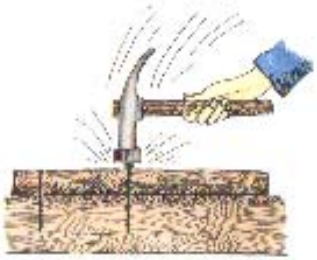


Figure 55

**Defect 22** - Loose or decayed planks on wooden bridge.

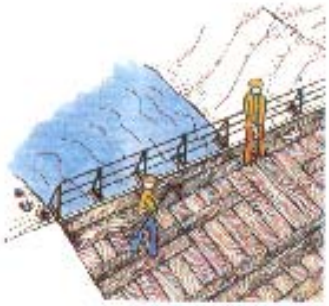


Figure 56

**Maintenance activity 22 - Replace bridge wooden planks**

Wooden planks should be protected from decay. Causes of decay should be found, and measures taken to prevent a repeat.

**Defect 23** - Bridge abutment quarter cone is damaged (damaged volume not exceed $1m^3$).

**Maintenance activity 23 – Repair bridge quarter cone**
Fill in damaged area with soil and compact; place stone on the surface using cement mortar of grade higher than 100 for bedding and jointing.

Figure 57

**Defect 24** – Loose stones on dry or mortared masonry apron (less than $2000cm^2$).

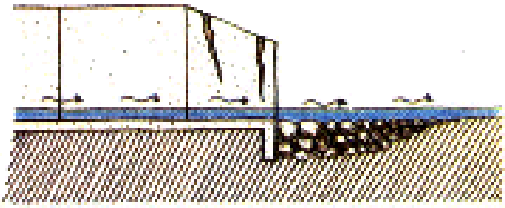


Figure 58

**Maintenance activity 24 – Repair apron**

Loosen surface: replace stone. For mortared masonry, use mortar grade 150.

**Defect 25** - Small area of missing stone on dry or mortared masonry retaining wall (less than 2000cm$^2$).

**Maintenance activity 25 – Repair retaining wall**

Replace missing stones using mortar grade 150.

Figure 59

**OTHER ROUTINE II MAINTENANCE ACTIVITIES** which may be required to be organised with the assistance of the District Authorities if the commune does not have capacity, include:-

26 Paint and repair traffic signs or guard rail

27 Fill pothole (bitumen road)

28 Seal individual or intersecting cracks (bitumen road)

29 Treat soft spots or ruts (bitumen road)

30 Corner break on concrete slab, crack on surface and damaged joint material.

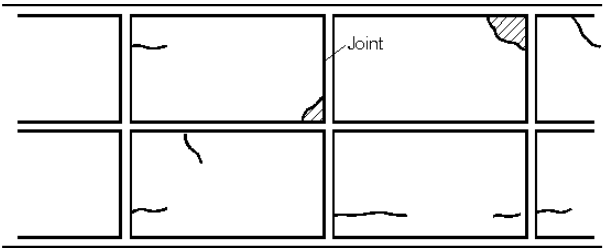



*Figure 60 - Two typical defects on cement concrete road*

## VII – DEFECTS OF BRIDGES, CULVERTS, RETAINING WALLS, DRIFTS, AND CAUSEWAYS WHICH EXCEED ROUTINE MAINTENANCE LIMIT

*Figure 61 - Rusted/eroded steel*

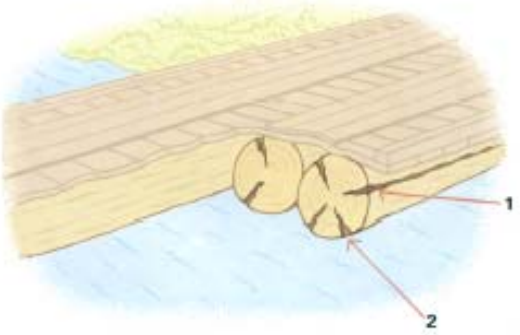



*Figure 62 - Decayed/rotten wood*

**Any of these defects should be reported to the District authorities if discovered, to mobilize the necessary advice and expertise, and help arrange resources to repair them.**

1. **Typical defects of reinforced concrete bridge**
   - Broken surface
   - Cracked surface
   - Cracked girder
   - Slide of quarter cone
   - Erosion of abutment foot, pier
   - Cracks on rubber bearing.

2. **Typical defects of steel truss bridge**
   - Damaged bolts
   - Loose rivets
   - Damaged welding joints (even minor defect)
   - Rusting or flaking paint cover on steel truss

3. **Typical defects of suspension bridge**
   - Loose plank (concrete or wooden planks)
   - Loose bolts and nuts
   - Oil and grease on cable weathered or disappeared
   - Rusted cable
   - Cracks on anchor block
   - Remarkable settlement and uneven settlement of bridge that can be seen by normal eyes

4. **Typical defects of culvert.**
   - Settlement cracks on culvert body
   - Culvert invert fretting
   - Settlement cracks on apron

**5. Typical defects of retaining wall.**

- Cracks.
- Skew wall.
- Convex area on wall surface.
- Damaged gabions.

**6. Typical defects of drift and causeway.**

- Concrete or masonry causeway is settled, cracked, broken.
- Large broken area on dry masonry drift.

**7. Defects of traffic signs and furniture.**

- Peeling of paint cover, rusted, unclear text.
- Broken guardrail or guideposts.

Figure 63 - Causeway washed out by flood


Figure 64 - Landslide caused by rainfall

# CHAPTER 6
# MAINTENANCE TASKS BEFORE AND DURING FLOOD SEASON

## I. FLOOD AND DAMAGES FOR ROAD TRANSPORT.

Vietnam is located in the area of tropical climate; the summer is hot. The temperature on a sealed pavement at 1 p.m. on a July day can be up to 65$^{o}$ C. The average rainfall is high with about 1,000 mm per year, but some areas receive more than twice this amount. But the rainfall is not equally distributed; it is mainly in early July and late August in the North. In the South, the wet season is mainly from May to September, inclusive. In the Central Region, the rain season is from September to October, inclusive. During the rain season in each region, there are heavy rains on some days. Such rainfall can cause powerful floods, washing away bridges and damaging roads etc. Especially in the coastal areas, floods together with tides can increase the water level higher than some sections of roads by more than a metre.

In addition to the damages of flood, the Central and Northern Regions are hit by the tropical storms from the Eastern Sea. Every year, on average there are 4 or 5 storms together with heavy rain, sweeping away or destroying many bridges, culverts and roads in Vietnam, causing losses worth VND billions.

## II. CONTEXT OF TRANSPORT STRUCTURE PROTECTION AND ASSURING THAT ROADS ARE CLEAR FOR PASSAGE IN THE WET SEASON:

The State has established a Central Committee of Storm and Flood Control. MOT has a Committee of Storm and Flood Control headed by an official of MOT. Every year, under the instruction of the State's Central Committee of Storm and Flood Control, the MOT Committee of Storm and Flood Control provides detailed instructions for works required to limit the damages when storms and floods occur. The basic content of these activities aims to protect transport structures and ensure roads will be kept clear for passage during the storms and floods. Following are the details of these activities:

1. Preparation:

- Completing structures or each part of the structures before the storms and floods.
- In each local area, there is a need to identify roads, bridges, culverts, embankments and drifts etc endangered or at risk to damage by floods.
- Defining technical solutions such as traffic channeling, making diversions and measures to re-establish traffic operation.
- Making plans for providing materials such as coarse stones, gabions, bridge beams, culvert pipes etc in order to timely respond to the damaged structure components, ensuring normal traffic operation during and after the storms and floods.
- Before the flood and storm season, there is a need to inspect the transport infrastructure system. Action should be taken immediately to consolidate any important components. If the consolidation work will exceed the MoT norm of routine maintenance

management, report to the management authority of higher level. Especially, attention needs to be paid to prevention of scour of bridge supports.

- Assigning people to keep roads clear for passage. Making plans for mobilizing labour and materials when roads are damaged.
- Making a list of Road Clearance Committee members and a list of road clearance groups.
- Arranging communications from villages to communes, districts and provinces.

2. Activities to be conducted before the monsoon:

- Before the monsoon, clear canals, side ditches, cut grass, cut excessive branch growth to prevent trees being blown down by storms, reinstall guide posts, sign posts, flood gauges (for causeway and submerged road) that are damaged or install them where there are not enough. Repair and stabilize sections with weak, slippery and muddy surface.
- For structures: remove obstacles under the bridges, on the submerged roads and causeways, dredge accumulated mud, clear culverts and manholes. Inspect and stabilize dikes, ferries and dams etc.
- Increase patrol in the monsoon to timely discover new, vulnerable locations.
- For the sections affected by flood, immediately repair defects of the pavement, edges, and slopes before the monsoon. Prepare replacement guideposts and flood gauges so that if the existing ones are damaged or lost they can be replaced at once when the road is flooded. Make plans for traffic diversions if the road is impassable when being flooded.
- Ferries are only allowed to operate when the wind is under level 7 and water speed is under 2m per

second. Above that limit, it is necessary to moor the transport at a safe shelter.

2. Activities conducted in the monsoon:

- In the monsoon, district and commune transport staff have to regularly monitor the weather on the radio, newspapers, instructions from the Committee of Flood and Storm Control at all levels to timely cope with floods and storms.
- During floods and storms, the maintenance manager must regularly inspect the important places on the roads and bridges in order to take immediate actions if there are any damages on the structures or on one component of a structure. Clear the drains where blocked.
- When there is a traffic blockage due to damage of bridges and roads, quickly channel or divert traffic as planned, mobilize labour to quickly make roads clear for passage.
- On the flooded sections, which are still passable, install guideposts to define the road area and the depth of flood to guide people and vehicles to travel right on the central line of the road. On the flooded roads, which are impassable, timely install barriers at both ends of the flooded section and warning posts to prevent passage of pedestrians and vehicles.
- On the bridges and culverts destroyed by flood but not yet repaired, and on the submerged roads and causeways with the water level higher than regulated, and impassable for vehicles, provide barriers to prevent passage by pedestrians and vehicles.
- In the days with heavy rain and flood, and storm of level 6 or higher, do not allow pedestrians and vehicles to travel on suspension bridges, cable bridges, or cross the river by boats or ferries.

- After the floods and storms, inspect all losses of the people and structures. Immediately repair what can be restored. Only leave the work on what does not affect the traffic operation or lead to the damage of other components, but report the outstanding work to the higher management level.

- Protection of transport structures and assuring clear roads for passage in the wet season is a difficult task, requiring a high level of responsibility, and immediate response to hazardous situations.

# CHAPTER 7
# EMERGENCY MAINTENANCE

## I. WHAT DOES EMERGENCY MAINTENANCE INVOLVE?

Emergency Maintenance is required to respond to incidents which sever or endanger road access or structures. For Commune Roads these activities should include:-

- Minor repair of bridge structures caused by erosion, flooding or vehicle damage (Steel, reinforced concrete or timber bridges), to sustain access while awaiting permanent repairs,
- Repair or replacement of failed, collapsed or washed out culverts
- Repair flood inundation, erosion or major settlement damage to road embankment and/or pavement,
- Remove landslide damage
- Temporary repair to road potholes or craters pending permanent repair
- Creating temporary traffic diversions routes for flooded roads, or if necessary for any of the foregoing incidents.

## II. NEED FOR INSTANT AND EFFECTIVE RESPONSE

By its nature, emergency maintenance is unpredictable and can be required at any time on the network when traffic passage is severed or endangered, or structures are jeopardised. However emergency situations normally occur in the rain/flood season. The important issue is to organize a rapid response to the situation when it arises.

## III. HOW TO RESPOND

A contingency or reserve amount should be allowed in the annual maintenance plan and budget to cope with emergencies.

Some emergency work may be carried out with the compulsory or voluntary labour resources in the commune.

Simple tasks can use the techniques described in Chapter 5. For other tasks, or where advice or outside skills, equipment of materials are required, then the Commune Maintenance Officer should consult with the District Transport staff.

The Emergency Maintenance work should aim to re-instate the road or structure to its previous condition, or make a temporary repair until resources can be organized to make the permanent repair.

Inspections should be carried out by the Commune Maintenance Officer after every flood to check for emergency requirements.

# CHAPTER 8
# SAFETY AND INSPECTIONS

## I – SAFETY IN MAINTENANCE.

There should be temporary warning signs at both ends of maintenance site to advise road users that works are in progress and to reduce vehicle speed.

Roadwork signs can be made by bamboo, wood or tole. Roadwork signs are made in a triangular shape with the MoT standard design of worker (see the picture 65).

*Height of sign 24cm*
*Width of sign 40cm*

Picture 65 - *Roadwork sign*

## II – ROAD INSPECTION AND OFFENCES TREATMENT.

According to the Norm on Rural Road Maintenance Management of MoT, there are 2 man days/year for road inspection. If there are 20km of road in a commune then up to 40 man days will be required per year for this task.

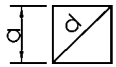
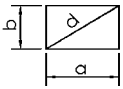
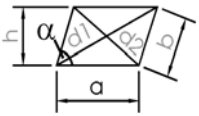
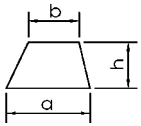
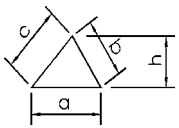
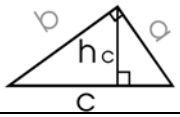
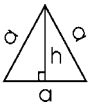
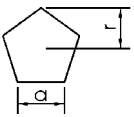
The Inspection task should be carried out periodically and extraordinarily (within and after flood or wet season). The Inspection task includes:

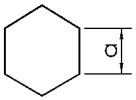
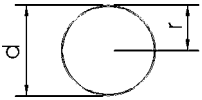
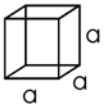
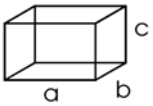
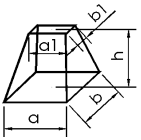
- Discover defects of structures and report to higher level, particularly drainage structures like bridges, culverts, ditches, retaining walls, drifts, causeways (See the section VII of chapter 5). Particular attention should be paid to hidden defects, for example probing to discover underwater erosion or scour at foundations.
- Discover offences of occupation of road reservation.
- Coordinate with other units to solve problems of road reservation offences or traffic accidents.
- Check and maintain visibility (see defect 1 of chapter 5).

# ANNEXES

# ANNEXES

## Annex 1
## Formulas for calculating area and volume of some common shapes

| | |
|---|---|
|   | $S = a^2$ *Square*<br>$d = a.\sqrt{2}$ |
|   | $S = a.b$ *Rectangular*<br>$d = \sqrt{a^2 + b^2}$ |
|   | $S = a \cdot h$<br>$= a \cdot b \cdot \sin\alpha$ |
|   | *Trapezium*<br>$S=h.(a+b)/2$ |
|   | *Triangle*<br>$S = a \cdot h/2$ |
|   | *Right triangle*<br>$S = a \cdot b / 2 = c \cdot h_c / 2$ |
|   | *Regular triangle*<br>$S = a^2 \cdot \sqrt{3} / 4$<br>$h = a. \sqrt{3} / 2$ |
|   | *Pentagon*<br>$S = 5r^2\sqrt{10+2\sqrt{5}}/8$ |

| | |
|---|---|
|  | $S = 3a^2\sqrt{3}/2$ *Hexagon* |
|  | $S = \pi . d^2/4 = \pi . r^2$ *Circle*<br>$U = \pi . d = 2 . \pi . r$<br>$\pi = 3,14$ |
|  | *Cube*<br>$V = a^3$ |
|  | *Rectangular parallelepiped*<br>$V = a . b . c$ |
|  | $V = \frac{1}{6} h . [(2a + a_1).b + (2a_1 + a).b_1]$ |

## Annex 2
## SPECIMEN contract, work report.
(Reference)

Depending on budget condition (labour days, cash or paddy rice payment), each locality can alter the terms and conditions of the contract in compliance with maintenance items and mode of payment

Peple's Committee
Commune.....

Socialist Republic of Vietnam
Independence – Freedom – Happiness

Date:.....

**CONTRACT ON**
**MAINTENANCE OF RURAL ROADS**

Pursuant to the decision of CPC regarding maintenance of rural roads.

Base on the practical situation of the commune.

The CPC ..... prepare the contract for maintenance of rural roads.

at PPC office

We are

A – CPC representatives (the client):

1. Mr/Ms: ....., Title .....
2. Mr/Ms: ....., Title .....
3. Mr/Ms: ....., Title .....
4. Mr/Ms: ....., Title .....

B – Contractor representatives:

1. Mr/Ms: ....., Title .....
2. Mr/Ms: ....., Title .....

To improve the performance and life time of roads, to serve the passage of people and vehicles and to meet the environmental requirements Green – Clean – Beautiful. After discussing content of the contract, the two parties have reached an agreement as follows:

**Article 1**: The CPC assign Mr/Ms ....., from .....commune .....district.... province responsibility of maintaining the following roads:

Village roads

| No. | Name of village | Road | Length (m) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| | | | |
| | Total | | |

Village main roads, inter-village and inter-commune roads:

| No. | Road name:<br>From.... | To | Length (m) |
|---|---|---|---|
| | | | |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| | | | |
| | Total | | |

+ Toal length (m):
  - Village roads: ..... m
  - Village main road, inter-village, inter-commune road ..... m

+ Total contracted road length .....m

**Article 2**: Norm of contracting and mode of payment.

a. Norm of contracting:
- CPC will provide ...VND per metre per year
- In the first year CPC will invest in ... wheelbarrow, ... hoe, ... shovel, ... crowbar by providing paddy rice as follows:

+Total length ....m x ...VND/m/year = ...VND/year
+ Initial investment in handtools = ...VND
+ Total payment in the first year = ...VND
(total in words)

b. Mode of payment:

+ CPC will make payment by crops, by years.
+ Time and location of payment:
  - 50% of payment made in crop 1 = ...VND
  - 50% of payment made in crop 2 = ...VND
  - In crop 1, deadline of payment is ...
  - In crop 2, deadline of payment is ...

+ Location of payment: in CPC, directly paid by the accountant and cashier.
+ Contract duration is one year from ... to ...

**Article 3**: Responsibilities of each party

1. Responsibilities of the client:

- The CPC will contract and check the implementation on the contracted roads and provide the record book.
- In the first year, the CPC will provide the contractor with ... wheelbarrow, ... hoe, ... shovel and ...crow bar (invested by cash equivalent to...VND).
- The CPC will provide information and make decision for establishing a team for road maintenance and cleaning (List of team members will be provided by the contractor).
- The CPC will broadcast the content of the provided contract.
- The CPC will send land administration staff to identify the start and end point of the road section and provide support when the work is beyond the capacity of the contractor.

2. Responsibilities of contractor:

- The contractor have to establish one team of at least 3 people to conduct the contract.
- Carry out inspection regularly to:
  + Prevent people from burning grass, dumping wastes and occupying road suface
  + Clean ditches and drainage
  + Clear grass or bushes overgrowing on roadsurface
  + Prevent people from digging road sides or building dams on road
- Carry out the following maintenance items:
  + Grass cutting (before and after rain season)
  + Ditch cleaning: make turn-out drain, do not leave any ponding water
  + Cleaning of side ditch.
  + Shoulder grading
  + Replenish shoulder and subgrade
  + Clearing small landslides
  + Cleaning road sections going through town (if any)
  + Pothole patching (earth, gravel).

+ Refill gravel
+ Clearing culverts and water flow
+ Clean bridge surface

- Timely report to the CPC about the violations against the environment and transport structure if they are beyond the contractor's responsibility.
- Maintaining equipment and facilities (keep them in good condition).

Note: The contractor is fully responsible for the damaging effect to the public welfare constructions as well as for the labour safety.

**Article 4**: General regulations

- During the contract implementation, if there are any difficulties or any arising problems, the contractor will have to timely report to the CPC. Both parties will need to agree the solutions.
- If the arising problems are reasonable, the CPC will arrange an addendum to the contract.
- If the contractor does not follow the contract, the CPC will penalise and terminate the contract at any time. The contractor will be compensated for work carried out according to the contract.
- If the contractor leaves the contract halfway through, the CPC will only pay for what has been properly completed. Moreover, the contractor will be penalized (The penalty level will be defined by CPC).

After the agreement, both parties will have to conduct the contract. Each party will have to take responsibility for its misconduct of the contract.

The completed contract is approved and signed by all parties mentioned in the contract.

The completed contract is made into two copies with the same validity.

- One copy given to contractor.
- One archived in the CPC.

**Contractor** **Divisions of CPC** **On behalf of CPC**

**Work report**

Work report no: . . . . . Date: . . . . . .
Province: . . . . . .District: . . . . . .
Commune: . . . . . .
Gang: . . . . . .
Road No: . . . . . .
From Km. . . . . .To Km . . . . . .
Location: . . . . . .
Work Achieved:
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Weather

Sunny ☐ Cloudy ☐ Rainy ☐

Note: Mark √ for the correct cell.

Manpower used

Name: . . . .. . . . . .Grade: . . . . . Hours worked: . . . . .
Name: . . . .. . . . . .Grade: . . . . . Hours worked: . . . . .
Name: . . . .. . . . . .Grade: . . . . . Hours worked: . . . . .

Equipment used

| Name, hrs | Diesel used |
|---|---|
| . . . . . , . . . . . hrs | . . . . . litres |
| . . . . . , . . . . . hrs | . . . . . litres |

Materials used

Materials used:

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

Comments

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

Foreman (Name and sign)

. . . . . .

## Annex 3
## VISUALITY AND CHECKING VISUALITY

Visibility is the required distance from a driver's eyes (1.2 m above the road surface) to the obstacle, in which there is enough time for him to get aware of the obstacle, brake the vehicle and for the vehicle to come to a halt on the road (due to the inertia) without crashing into the obstacle.

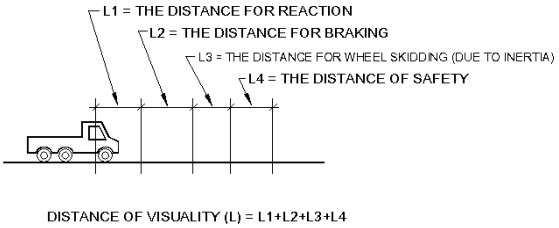
The visual distance depends on the speed of vehicle (by the road class), the minimum radius of curve. Based on the calculations and measurement results, the minimum visual distance is defined as follows (according to Vietnamese Standard TCVN-4054-85):

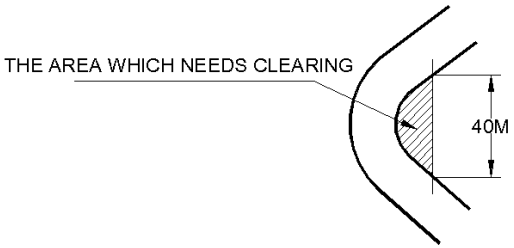
Table 11

| Vehicle speed | Curve radius | Required visibility |
|---|---|---|
| 60 km/h | R = 130 m | 150 m |
| 40 km/h | R = 60 m | 60 m |
| 25 km/h | R = 25 m | 40 m |

To identify if there are any bushes or small straw huts inside any curve or not; to identify if the bushes prevent the visibility or not, you do as follows:

Stretch a string 40 m long (if the required visibility is 40 m) at the altitude of 1.2 m above the road surface and at point 1.5 m away from the edge. Stretch the string though the curve. All bushes within the line and the curve must be cleared to ensure the visibility.




Picture 66 – Checking visuality

# Annex 4
## INTRODUCTION TO THE SPECIFICATIONS OF SOME TYPES OF MATERIALS NORMALLY USED FOR RURAL ROAD MAINTENANCE.

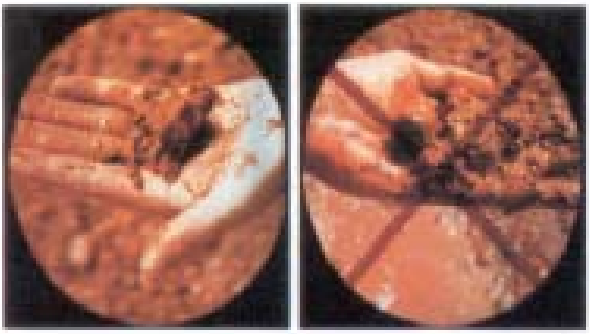
Typical rural road surfacings in Vietnam are earth, gravel, and stone macadam. Bituminous and concrete surfaces are also used in some areas. Within the scope of this handbook for commune level, only some materials used for maintenance of earth, gravel, stone macadam and cement concrete are introduced.

### I. Soil material

Soil is an indispensable material in construction and maintenance of rural roads. Soil is used to construct subgrade. The earth surface is the top surface of subgrade compacted to achieve camber and smoothness. 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. (See figure 67)

Figure 67: Quick identification of appropriate moisture content at site



1.1. Some commonly used soil for subgrade filling:

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

1.2. 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

When these kinds of soil are used for filling, the following instructions must be followed:

➢ The use of soil dust, sand dust and sand for filling subgrade must be decided by specialist staff and it must be constructed in special ways, compaction must be assured and camber erosion prevention measures must be done.

➢ If coarse sand is used for filling then sand must be laid in layers, each layer must be watered, but no too much, and then compacted.
➢ If rubble mixed with soil is used then it must be added with clay and treated to achieve appropriate moisture content before laying out. If a roller is not available then rubble over 10cm should not be used. Oversize pieces of rubble may be broken down using sledgehammers.
➢ In low lying land areas, where only organic clay is available for filling subgrade then spades or shovels should be used to cut the clay into pieces of single size and as big as possible. For the first layer, place clay pieces on their ends with hard end facing up. For the second and subsequent layers, place clay pieces on their edges with hard end facing outside. Clay pieces should be placed side by side as close as possible. Clay pieces are placed in layers from the centre to the outer edge of the road. Some people should step on it while placing to increase the density.

1.3. 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)

1.4. Soil classification:
RITST already provide a simple table of soil classification used at site (table 12)

## Table 12: 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 single type | Only fine and smooth particles are seen | Difficult to break into small particles | Plastic and sticky | Easy to roll into stick shape with diameter < 3mm, easy to roll into round shape | Smooth and polished section |
| Clay soil (or heavy soil | Fine particles of different types | Particle size is over 0.25mm | Easy to break | 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 break | Less sticky Less plastic | Difficult to roll into stick | Rough section |

## II. Crushed stone.

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/$cm^2$ 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%.

**III. Cement concrete.**

**1. Definition:**

Cement concrete (or concrete) is a mixture of 4 materials including chippings, sand, cement and water mixed at a certain proportion. Key materials are sand and chippings, which provide strength for concrete. Cement and water act as a binder.

Grade of cement concrete defines its compression strength in terms of KG/cm2. Concrete samples are tested to identify grade of concrete after 28 days of curing.

Concrete is mixed by mixer or by hand.

## 2. Advantages and disadvantages of cement concrete.

Table 13

| Advantages | Disadvantages |
|---|---|
| • Water proof, heat proof.<br>• Resistant to oil droppings from vehicles<br>• High compression strength.<br>• Local materials can often be used.<br>• Concrete can be made with required size, shape and strength. | • High construction cost<br>• Expansion joints must be in place to accommodate high contraction and expansion of concrete. Therefore, surface is rougher than bituminous surface.<br>• Less flexible, easy to be cracked. |

## 3. Materials for cement concrete.

3.1. 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.

3.2. 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/$m^3$ or higher and must be 1300kg/$m^3$ 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.

3.3. 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.

3.4. 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.

**4. Mixing rate of concrete.**

Cement concrete used for rural roads normally consists of chippings of 1 x 2cm and 2 x 4cm with grade of 200 and 250 with the following mixing rates:

4.1. Mixing rate of materials for 1m$^3$ of cement concrete with chippings size of 1 x 2 cm:

Table 14

| Code | Material | Unit | Cement concrete | |
|---|---|---|---|---|
| | | | Grade200 | Grade250 |
| C222 | Cement PC30 | Kg | 379.05 | 455.7 |
| | Coarse sand | m$^3$ | 0.504 | 0.4648 |
| | Chippings | m$^3$ | 0.812 | 0.8082 |

4.2. Mixing rate of materials for 1m$^3$ of cement concrete with chippings size of 2 x 4cm:

Table 15

| Code | Material | Unit | Cement concrete | |
|---|---|---|---|---|
| | | | G#200 | G#250 |
| C223 | Cement PC30 | kg | 359.1 | 425.25 |
| | Coarse sand | m$^3$ | 0.5096 | 0.47824 |
| | Chippings | m$^3$ | 0.8124 | 0.80676 |

## 5. Material for expansion joints on concrete surface.

Due to the contraction and expansion of concrete in low and high temperature respectively, expansion joints should be provided between concrete slabs. Material for filling joints is normally bituminous mastic (mostly sand mixed with bitumen) and is produced as follows: use 60 – 65% of bitumen with penetration grade of 60/70 heated at 120$^0$C to mix with 10% of coarse sand medium size and 25 – 30% of stone powder.

## IV. Gravel

### 1. Concept of gravel:

Gravel material is a mix of different particle sizes, which follow the same grading principles as stone aggregates in cement concrete and asphalt concrete.

Gravel materials have high density. Air voids between particles of the same size must be filled by finer materials. Therefore the contents of material by particle size should be assured to meet the optimum grading. Lack of any particle size or contents of material will break the rule of granular grading.

### 2. Some types of gravel:

- Alluvial gravel: it is often seen in, or close to, rivers or streams, They often lack plasticity and therefore clay should be added to compensate.
- Colluvial gravel: often seen in rolling terrain which is formed by boulders, sand and clay. If there is too much clay then it should be screened out.
- Laterite: often seen in rolling terrain. Laterite is often mixed with clay. This material should be tested and screened before laying out on road.
- Coarse laterite: Coarse laterite is crushed into smaller aggregates and then mixed with clay before laying out.

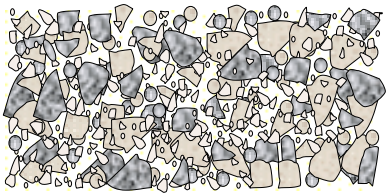


Figure 68: Aggregates of different size mixed together following grading rule to make gravel.

## V. Mortar

### 1. Concept

Mortar is a mixture of sand, water, binder (lime, cement) mixed at a fixed rate. After mixing it becomes a plastic binding material to bind material particles, which then sets into a rigid mass.

### 2. Classification:

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
- 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.

### 3. Properties of mortar.

A good mortar must meet the following requirements:

➢ Plasticity (soft and liquid):

Plasticity affects the softness or hardness of mortar. Mortar with good plasticity is good for building and surfacing. Mortar plasticity depends on elements like water content, binder type and binder quantity.

➢ Layer division:

Layer division is the change of mixing rate of mortar that can be seen from the height of mortar when transported or left unused for a period of time. The clearer the division layer the worse the mortar quality.

➢ Water holding: mortar should hold water so that it does not fall apart when transported.

➢ Adhesion of mortar:

Adhesion of mortar shows its binding capability with materials. Mortar used for construction work must have good adhesion. Adhesion of mortar depends on quantity, and quality of binder. Materials for mortar must be assured of quantity and quality and should be mixed carefully. The following test can be done to identify the adhesion of mortar:

- Use mortar to bind 2 bricks and maintain it properly
- Pull to separate the two bricks
- If the damage track is seen in the middle of the mortar then the mortar has good adhesion. If the damage sign is seen on the contact surface between brick and mortar then the brick has poor adhesion.

➢ Strength of mortar.

Strength of mortar (mortar grade) is the compression capacity of mortar per area unit of a test mortar sample in cubic shape of 7.07cm, which is cured for 28 days. Normally, mortar is produced with the following grades:

10; 25; 50; 75; 100; 150; 200; 300 ($KG/cm^2$).

Requirements for mortar grade depend on structures to be built.

## 4. Mixing rates of mortar.

The following table can be used to identify mixing rate of mortar:

Mixing rates for $1m^3$ of building and surfacing mortar.

Table 16

| Mortar type | Mortar grade | Cement grade | Material used for 1m$^3$ of mortar | | |
|---|---|---|---|---|---|
| | | | Cement (kg) | Quick lime (kg) | Sand (m$^3$) |
| Mixed mortar with coarse sand | 100 | 400 | 216 | 36 | 0.850 |
| | | 300 | 301 | 30 | 0.826 |
| | | 250 | 378 | 12 | 0.755 |
| | 75 | 400 | 201 | 53 | 0.910 |
| | | 300 | 234 | 46 | 0.892 |
| | | 200 | 302 | 37 | 0.850 |
| | 50 | 400 | 130 | 61 | 0.930 |
| | | 300 | 165 | 59 | 0906 |
| | | 200 | 215 | 57 | 0901 |
| | 25 | 400 | 71 | 101 | 0.974 |
| | | 300 | 88 | 94 | 0.968 |
| | | 200 | 131 | 82 | 0.902 |
| | 10 | 400 | 36 | 110 | 1.064 |
| | | 300 | 46 | 101 | 0.987 |
| | | 200 | 57 | 90 | 0.979 |
| Mixed mortar with fine sand | 50 | 400 | 180 | 55 | 0.920 |
| | | 300 | 244 | 43 | 0.890 |
| | | 200 | 305 | 36 | 0.780 |
| | 25 | 400 | 110 | 93 | 0.960 |
| | | 300 | 132 | 78 | 0.936 |
| | | 200 | 152 | 62 | 0.900 |
| | 10 | 400 | 55 | 72 | 0.990 |
| | | 300 | 77 | 84 | 0.980 |
| | | 200 | 85 | 88 | 0.975 |
| | 8 | 400 | 32 | 105 | 0.996 |
| | | 300 | 44 | 98 | 0.994 |
| | | 200 | 50 | 84 | 0.990 |

| Mortar type | Mortar grade | Cement grade | Material used for 1m$^3$ of mortar | | |
|---|---|---|---|---|---|
| | | | Cement (kg) | Quick lime (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 |

Instructions for using the table:

- 1 kg of quick lime provides 1.6 litre of hydrated lime.
- Example: look up the table and find out the mixing rate for the mixed mortar with coarse sand, grade 75, cement grade 300.

The results for 1m$^3$ of mortar is as follows:

- Cement 234 kg
- Quick lime 46 kg (46 x 1.6 = 73.6 litre of hydrated lime)
- Coarse sand 0.892m$^3$.

## Annex 5
## HANDTOOLS AND SOME LIGHT EQUIPMENT USED IN MAINTENANCE

### I. SOME HANDTOOLS FOR RURAL ROAD MAINTENANCE

1. Hoe: Hoe is used to dig out soil. Hoe can dig soft soil without stones

2. Pickaxe: Pickaxe is used to loosen soil, particularly hard soil with stones

3. Crowbar: Crowbar is also used to dig soil. Crowbar can dig any kind of soil. Crowbar is used to prise big stones.

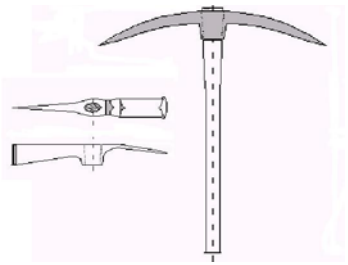
4. Shovel: Shovel is used to spread out soil and material. Shovel can be used to dig or cut soft soil if necessary.

5. Spade: Spade is used to dig soft soil, particularly soil in low-lying land. Spade can cut soil in panels convenient for transportation

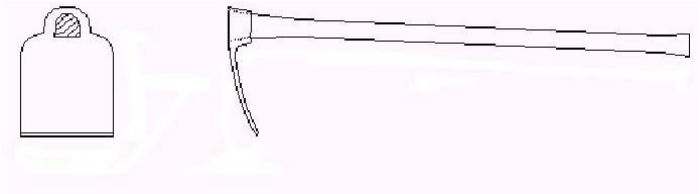
6. Hammer: Hammers are of various weights. Big (sledge) hammer of 5 to 6 kg is used to break coarse stones. Smaller hammer is used to produce stones for dressed stone and hand packed stone surfaces etc.

Figure 69 – Some handtools for rural road maintenance

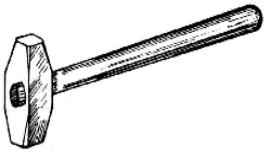
Shovel

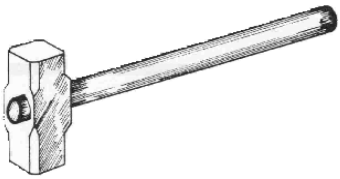


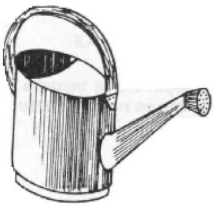
Pick-axe

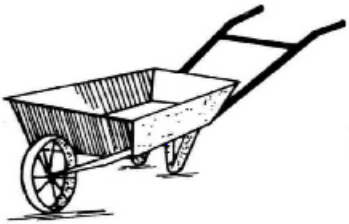


Hoe









7. Bamboo framed baskets:
   Bamboo framed baskets are used to transport soil, material within haulage distances of 10 to 20m and can pass steep gradients in any condition. Light and non-sticky baskets can be used for this purpose.

8. Modified wheel-barrow: Modified wheel-barrow is the commonly used vehicle for transporting material within distance of 20 to 80m. Modified wheel-barrow has high capacity, low cost and is appropriate for many types of roads. Normal wheel-barrow can also be used for transporting material.
9. Grading plate: Grading plate is used to grade soil and material. High capacity, simple technique.

10. Wooden/cast iron rammer: Used for compaction of earth, gravel/laterite roads etc. Rammer weight is from 30 to 40kg.

Some other handtools are: watering can, bitumen heater, bamboo broom to sweep small chippings in construction and maintenance of water bound macadam.

## II. Light equipment used in rural road maintenance

Hand tools are almost all that is required for routine maintenance of rural roads for operations that are not requiring complicated techniques (Routine 1). For more complicated works such as Routine 2, periodic maintenance or emergency works, mechanised equipment is usually required. In the scope of this handbook, only some light equipment such as soil compactor (roller, vibrating compactor), stone crusher, concrete mixer, tractor for towing grader are introduced.

### 1. Soil compactor:

Soil compactors help to compress soil and increase soil strength against traffic loading, depression, cracks and water.

Soil compactors are used to compact the road surface after filling subgrade, repairing soft spots and potholes etc. Light compactors appropriate for maintenance of rural roads are mini vibrating roller, pedestrian roller, vibrating compactor, etc.

1.1. Mini vibrating roller:

It has the advantage of light weight and small size (the weight is from 0.5 to 1 ton) which is convenient for compacting the road surface after repairing and patching potholes. Currently this type of roller is manufactured in Vietnam. It is cheap, and easy to operate and transport between sites. It is therefore suitable for small contractors (figure 70).

Some light equipment for construction and maintenance of rural roads.


Figure 70: Mini vibrating roller CR 10A (1000 kg)


Figure 71: Pedestrian roller

1.2. Pedestrian roller:

Main components of the machine include steel rollers, an engine to operate the vibrator and propel the machine. The machine is fitted with a handle for the operator to control. This roller is of light weight (typically 500kg), easy to operate and suitable for compacting road shoulder and patching. It is easy to transport between sites (figure 71).

1.3. Vibrating plate compactor:

Vibrating plate compactor (figure 72) can be used to compact for patching of potholes, and soft spots. It is particularly suitable for operating in limited areas such as next to bridge pillars, areas under bridges, which are inaccessible for rollers. This compactor is best used with sandy soil, sandy stone, gravel, and fine chippings. It is not suitable to use with clay.

## 2. Stone crusher

Stone crushers are used to produce chippings for construction and maintenance of roads, and core materials for cement concrete.

Currently, low capacity stone crushers are used to produce chippings for maintenance and construction of rural roads (figure 73). Advantages of this machine are light weight, easy to transport and suitable for small contractors.

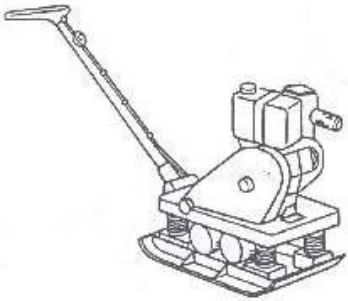


Figure 72: Vibrating compactor

Figure 73: Low capacity stone crusher (5$m^3$/h)

### 3. Concrete mixer

Concrete mixer is used to produce concrete from the component materials.
Main components of the machine are mixer drum, material supply facility, facility for pouring complete mixture, engine, transmission parts and machine frame.
Normally, low capacity mixers from 100 to 500l/mixing and output from 5 to 7 $m^3$/h (figure 74) are used for maintenance of rural roads.

### 4. Tractor

In construction and maintenance of rural roads, a trailer is often towed by a tractor to transport material and equipment. A grader can be towed by a tractor to grade road surface, and restore the camber (figure 75).

Figure 74: Concrete mixer with capacity of 5$m^3$/h

Figure 75: A tractor towed grader

## Annex 6
## NORMS OF RURAL ROAD MAINTENANCE WORKS.

I. General regulation:

1. The MoT Norms for Management and Routine Maintenance of Rural Roads are the basis for management and calculating cost estimates of management and maintenance items of rural roads. This Norms are not used for signing maintenance contracts with workers.

2. Norms for management and routine maintenance of rural roads are only applied for district and commune roads. Work items or surfacing that are not mentioned in this norm should be referred to in other relevant documents such as MoT Norms for routine maintenance of roads issued on 19 October 2001.

II. Norms for Management and Routine Maintenance of Rural Roads.

1. Norms for bituminous surfaces.
*(Full penetration macadam, semi-penetration macadam, and surface dressing)*

*Subgrade width: 4 – 6m* *Surface width: 2.5 – 3.5m*

*Calculate for 1 km/year*

| No | Work items | Unit | Work norms | | | Average productivity | Remarks |
|---|---|---|---|---|---|---|---|
| | | | Mountain | Rolling | Flat | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | Management | | | | | | |
| 1 | Inspection, settlement of offences | Man day (md) | 2 | 2 | 3 | | |
| B | Traffic safety | | | | | | |
| | Paint&repair guide posts and signs | - | 1 | 1 | 1 | | |
| C | Subgrade and drainage | | | | | | |
| 3 | Grass cutting | - | 4 | 3 | 2 | | |
| 4 | Ditch cleaning in wet season | - | 3 | 2 | 2 | | |
| 5 | Ditch re-excavating | m | 600 | 500 | 400 | 30m/md | |
| 6 | Shoulder levelling | $m^2$ | 400 | 400 | 400 | 24$m^2$/md | |
| 7 | Side & cross ditch excavating | $m^3$ | 6 | 5 | 5 | 1$m^3$/md | |
| 8 | Replenishing shoulder & subgrade | - | 6 | 5 | 5 | 2$m^3$/md | |
| 9 | Landslide removal | - | 4 | 4 | 0 | 2$m^3$/md | |
| 10 | Clean town sections (if necessary) | md | 2 | 2 | 2 | | |
| D | Pavement | | | | | | |
| 11 | Pothole patching on bituminous road | $M^2$ | 20 | 20 | 20 | 3.5$m^2$/md | |
| 12 | Crack sealing | $m^2$ | 60 | 60 | 60 | 20$m^2$/md | |
| 13 | Plastic deformation treatment | $m^3$ | 2 | 2 | 2 | 0.7$m^3$/md | |
| E | Culvert + Bridge < 10m | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14 | Culvert clearing | md | 1 | 1 | 1 | | |
| 15 | Bridge deck cleaning | md | 1 | 1 | 1 | | |

## 2. Norms for crushed stone surface

*Subgrade width: 4 – 6m  Surface width: 2,5 – 3,5m*
*for 1 km/year*

| No | Work items | Unit | Work norms | | | Avr. Productivity | Remark |
|---|---|---|---|---|---|---|---|
| | | | Mount. | Rolling | Flat | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | Management | | | | | | |
| 1 | Inspection, settlement of offences | md | 2 | 2 | 2 | | |
| B | Traffic safety | | | | | | |
| | Paint&repair guide posts and signs | - | 1 | 1 | 2 | | |
| C | Subgrade and drainage | | | | | | |
| 3 | Grass cutting | - | 4 | 3 | 2 | | |
| 4 | Ditch cleaning in wet season | - | 3 | 2 | 2 | | |
| 5 | Ditch re-excavating | m | 800 | 600 | 600 | 30md/md | |
| 6 | Shoulder levelling | $m^2$ | 400 | 400 | 400 | 24$m^2$/md | |
| 7 | Side & cross ditch excavating | $m^3$ | 6 | 5 | 5 | 1$m^3$/md | |
| 8 | Replenishing shoulder & subgrade | - | 8 | 5 | 5 | 2$m^3$/md | |
| 9 | Landslide removal | - | 10 | 6 | 0 | 2$m^3$/md | |
| 10 | Clean town sections (if necessary) | md | 2 | 2 | 2 | | |
| D | Pavement | | | | | | |
| 11 | Pothole & edge break repair | $m^2$ | 35 | 35 | 40 | 5$m^2$/md | |
| 12 | Clean surface | $m^2$ | 1200 | 1200 | 1200 | 200$m^2$/md | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | & add coarse sand | | | | | | |
| 13 | Plastic deformation treatment | $m^3$ | 2 | 3 | 3 | 0.7$m^3$/md | |
| E | culvert+bridge < 10m | | | | | | |
| 14 | Culvert clearing | md | 1 | 1 | 1 | | |
| 15 | Bridge deck cleaning | md | 1 | 1 | 1 | | |

## 3. Norms for gravel surface

*Subgrade width: 4 – 6m* *Surface width: 2,5 – 3,5m*

*For 1 km/year*

| No | Work items | Unit | Work norms | | | Avr. Productivity | Remarks |
|---|---|---|---|---|---|---|---|
| | | | Mount. | Rolling | Flat | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | Management | | | | | | |
| 1 | Inspection, settlement of offences | md | 2 | 2 | 3 | | |
| B | Traffic safety | | | | | | |
| | Paint&repair guide posts and signs | - | 1 | 1 | 1 | | |
| C | Subgrade and drainage | | | | | | |
| 3 | Grass cutting | - | 4 | 3 | 2 | | |
| 4 | Ditch cleaning in wet season | - | 3 | 2 | 2 | | |
| 5 | Ditch re-excavating | m | 800 | 700 | 600 | 30md/md | |
| 6 | Shoulder levelling | $m^2$ | 450 | 400 | 400 | 24$m^2$/md | |
| 7 | Side & cross ditch excavating | $m^3$ | 10 | 10 | 5 | 1$m^3$/md | |
| 8 | Replenishing shoulder & subgrade | - | 8 | 5 | 5 | 2$m^3$/md | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | Landslide removal | - | 10 | 5 | 0 | $2m^3$/md | |
| 10 | Clean town sections (if necessary) | md | 1 | 2 | 2 | | |
| D | Pavement | | | | | | |
| 11 | Pothole repair | $m^2$ | 60 | 70 | 80 | $7m^2$/md | |
| 12 | Corrugation grading | $m^2$ | 9 | 10 | 10 | $10m^2$/md | |
| 13 | Clean surface & add coarse sand | $m^2$ | 1200 | 1200 | 1200 | $200m^2$/md | |
| 14 | Plastic deformation treatment | $m^3$ | 2 | 3 | 3 | $0.7m^3$/md | |
| 15 | Watering surface | md | 7 | 8 | 9 | | |
| E | Culvert + bridge < 10m | | | | | | |
| 16 | Culvert clearing | md | 1 | 1 | 1 | | |
| 17 | Bridge deck cleaning | md | 1 | 1 | 1 | | |

## 4. Norms for earth surface.

*Subgrade width: 4 – 6m  Surface width: 2,5 – 3,5m*
*For 1 km/year*

| No | Work items | Unit | Work norms | | | Avr. productivity | Remarks |
|---|---|---|---|---|---|---|---|
| | | | Mount | Rolling | Flat | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | Management | | | | | | |
| 1 | Inspection, settlement of offences | md | 2 | 2 | 3 | | |
| B | Traffic safety | | | | | | |
| | Paint&repair guide posts and signs | - | 0.5 | 0.5 | 1 | | |
| C | Subgrade and drainage | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | Grass cutting | - | 4 | 3 | 2 | | |
| 4 | Ditch cleaning in wet season | - | 3 | 2 | 2 | | |
| 5 | Ditch re-excavating | m | 600 | 500 | 400 | 30md/md | |
| 6 | Shoulder levelling | $m^2$ | 400 | 400 | 400 | $24m^2$/md | |
| 7 | Side & cross ditch excavating | $m^3$ | 6 | 5 | 5 | $1m^3$/md | |
| 8 | Replenishing shoulder & subgrade | - | 6 | 5 | 5 | $2m^3$/md | |
| 9 | Landslide removal | - | 4 | 4 | 0 | $2m^3$/md | |
| 10 | Clean town sections (if necessary) | md | 2 | 2 | 2 | | |
| D | Pavement | | | | | | |
| 11 | wheel ruts, corrugation grading | $m^2$ | 10 | 10 | 10 | $10m^2$/md | |
| 12 | Pothole repair | $m^2$ | 80 | 100 | 120 | $8m^2$/md | |
| 13 | Plastic deformation treatment | md | 8 | 9 | 8 | $0.7m^3$/md | |
| 14 | watering surface | - | 8 | 8 | 8 | | |
| E | culvert + bridge < 10m | | | | | | |
| 15 | Culvert clearing | md | 1 | 1 | 1 | | |
| 16 | Bridge deck cleaning | md | 1 | 1 | 1 | | |

## Annex 7
## EXAMPLES ON COST ESTIMATES FOR MAINTENANCE OF RURAL ROADS

The purpose of these examples is to provide a consistent way of making cost estimates. In fact, some work items defined in the norms may not be required to be carried out, such as cleaning road sections through towns. The cost estimates must be based on site surveys of actual maintenance needs. Moreover, unit costs will vary by regions and time. Therefore these examples are for reference only.

**I.** Examples on cost estimating for maintenance of some types of rural roads:

### 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** | |

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

Table 19

| No. | Consuming items | Unit | Quantity | Unit cost | Cost | Remark |
|---|---|---|---|---|---|---|
| 1 | Material | | | | | |
| | chipping 4x6 | $m^3$ | 0.1319 | 133000 | 17542.7 | |
| | chipping 2x4 | $m^3$ | 0.0036 | 138000 | 496.8 | |
| | chipping 1x2 | $m^3$ | 0.0237 | 176000 | 4171.2 | |
| | chipping 0,5x1 | $m^3$ | 0.022 | 142800 | 3141.6 | |
| | firewood | kg | 2.6 | 320 | 832.0 | |
| | Bitumen | kg | 3 | 3714 | 11142.0 | |
| 2 | Labour | | | | | |
| | grade 3,5/7 | md | 0.28 | 12430 | 3480.4 | |
| 3 | Equipment | | | | | |
| | Roller 8,5T | shift | 0.0147 | 266728.27 | 3920.9 | |
| | **Total** | | | | **44727.6** | |

1.3. Pothole filling on water bound macadam: Average depth of pothole is 10cm, calculated for 1m$^2$.

Table 20

| No | Consuming items | Unit | Quantity | Unit cost | Cost | Remark |
|---|---|---|---|---|---|---|
| 1 | Material | | | | | |
| | chipping 4x6 | $m^3$ | 0.1319 | 133000.00 | 17542.7 | |
| | chipping 2x4 | $m^3$ | 0.0036 | 138000.00 | 496.80 | |
| | chipping 1x2 | $m^3$ | 0.0037 | 176000.00 | 651.20 | |
| | chipping 0,5x1 | $m^3$ | 0.0049 | 142800.00 | 699.72 | |
| | Coarse sand | $m^3$ | 0.032 | 54300.00 | 1737.60 | |
| 2 | Labour | | | | | |
| | grade 2,7/7 | md | 0.2 | 11552.03 | 2310.41 | |
| 3 | Equipment | | | | | |
| | Roller 8,5T | shift | 0.0147 | 266728.27 | 3920.9 | |
| | Other equipment | % | 5 | | 196.05 | |
| | **Total** | | | | **27555.4** | |

1.4. Sealing cracks with bitumen: calculated for 1m$^2$.

Table 21

| No. | Consuming items | Unit | Quantity | Unit cost | Cost | Remark |
|---|---|---|---|---|---|---|
| 1 | Material | | | | | |
| | Chipping | $m^3$ | 0.0178 | 142800.00 | 2541.84 | |
| | 0,5x1 | kg | 2.14 | 3714.00 | 7947.96 | |
| | Bitumen | | 2 | 320.00 | 640.00 | |
| 2 | Firewood | | | | | |
| | Labour | md | 0.05 | 12430.15 | 621.5 | |
| 3 | grade 3,5/7 | | | | | |
| | Equipment | shift | 0.008 | 266728.27 | 2133.83 | |
| | Roller 8,5T | | | | | |
| | **Total** | | | | **13885.13** | |

1.5. Plastic deformation treatment:
0.63m depth calculated for 1m$^3$.

Table 22

| No. | Surface type | Unit cost | | | Total |
|---|---|---|---|---|---|
| | | Material | Labour | Equipment | |
| 1 | Gravel | 95081.61 | 9926.16 | 12812.96 | **117820.73** |
| 2 | Waterbond | 102388.4 | 13496.6 | 16897.57 | **132782.58** |
| 3 | macadam | 129201.8 | 16710.23 | 16506.04 | **162418.11** |
| | Penmac | | | | |

## 2. Management and routine maintenance cost of rural roads:

2.1. Bituminous surface:
(Full penmac, semi penmac, surface dressing)

Dimension:

- Subgrade: 4 – 6m
- Surface: 2.5 – 3.5m

Calculated for 1 km/year (see table 23 )

Table 23

| No. | Work items | Unit | Norms | Unit cost | | | Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Material | Labour | Equipment | Material | Labour | Equipment | |
| **A** | **Management** | | | | | | | | | |
| 1 | Inspection, offences settlement | Md | 3 | | 10000 | | | 30000 | | 3 |
| **B** | **Traffic safety** | | | | | | | | | |
| 2 | Paint & repair guide posts, signs | Md | 1 | | 10000 | | | 10000 | | 1 |
| **C** | **Subgrade & drainage** | | | | | | | | | |
| 3 | Vegetation cutting | Md | 2 | | 10000 | | | 20000 | | 2 |
| 4 | Ditch cleaning in wet season | - | 2 | | 10000 | | | 20000 | | 2 |
| 5 | Side ditch desilting | - | 400/30 | | 10000 | | | 133000 | | 13.3 |
| 6 | Shoulder levelling | - | 400/24 | | 10000 | | | 166000 | | 16.6 |
| 7 | Excavating cross/side drain | - | 5/1 | | 10000 | | | 50000 | | 5 |
| 8 | Replenish shoulder+subgrade | - | 5/2 | | 10000 | | | 25000 | | 2.5 |
| 9 | Small landslide removal | - | 0 | | 10000 | | | 20000 | | 2 |
| 10 | Cleaning town sections | - | 2 | | 10000 | | | | | |
| **D** | **Road surface** | | | | | | | | | |
| 11 | Pothole filling | $m^2$ | 20 | 37326.3 | 3480.4 | 3920.9 | 746526 | 69608 | 78418 | 5.6 |
| 12 | Cracks sealing | $m^2$ | 60 | 11129.8 | 621.5 | 2133.83 | 667788 | 37290 | 128030 | 3 |
| 13 | Plastic deformation treatment | $m^3$ | 2 | 129202 | 16710.2 | 16506 | 258404 | 33420.4 | 33012 | |
| | Culvert + bridge < 10m | | | | | | | | | 2.86 |
| 14 | Channel clearing | Md | 1 | 10000 | | | | 10000 | | 1 |
| 15 | | | 1 | 10000 | | | | 10000 | | 1 |
| | **Total** | | | | | | **1627718** | **634318** | **239460** | **60.86** |

- Direct cost:

T = VL+NC+M = 1627718+614901+239460 = 2482079

- Overheads:

C = 66% x NC = 614901 x 66% = 405834.66

- Benefits:

TL = 6% x (T+C) = (2482079+405834.66) x 6% = 173274.81

- Cost estimates before tax:

Z =T+C+TL= 2482079+405834.66+173274.81 =3061188.5

- Output VAT

VAT = Z x 5% = 153059.43

- Cost estimates after tax:

G = Z + VAT = 3214247.93

- Management cost before tax:

$K_{tt}$ = 1% x Z = 30611.89

- Management cost after tax:

$K_{st} = K_{tt} + K_{tt}$ x 5% = 1530.6 + 30611.89 = 32142.49

- Total estimates:

X = G + $K_{st}$ = 3214247.93+32142.49 = 3246390.42

## THE LIST OF MAINTENANCE DEFECTS

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*Computer technique: Bach The Dung*