Intech Associates
CONSULTING ENGINEERS

IN ASSOCIATION WITH

Transport Development Strategy Institute

SUPPORTED BY

DFID Department for International Development

# MINISTRY OF TRANSPORT VIETNAM

## Rural Transport Project 2

# RRST GUIDELINES

# RURAL ROAD PAVEMENT AND SURFACE MAINTENANCE

March 2007

# FOREWORD

These Guidelines have been prepared as an assignment by Intech-TRL under the South East Asia Community Access Programme (SEACAP) funded by DFID under support for the Vietnam Ministry of Transport second Rural Transport Programme (RT2).

The Guidelines synthesize the knowledge and experience developed under the Rural Road Surfacing Research (RRSR), Rural Road Surfacing Trials (RRST) and other initiatives to develop and improve the maintenance of the rural road infrastructure in Vietnam. The Guidelines also draw on international experience and specifically the PIARC (World Road Association) International Road Maintenance Handbook.

Local experience and knowledge has also been compiled and contributed to develop draft recommendations on good practices and Cost Norms for the range of surfacing and paving options suitable for application in appropriate circumstances in the various regions and physical environments encountered in Vietnam.

It is anticipated that these Guidelines will be in provisional format until the results of the planned monitoring of the RRST trial pavements have been obtained and the recommendations can be refined based on that experience.

The Guidelines are intended to fill an identified current gap in knowledge and guidance for Provincial Administrations who need to plan and organize maintenance of the expanding and valuable rural road network asset.

These Guidelines do not include guidance on the maintenance of rural road structures, such as bridges, culverts and other watercourse crossings, as this is a specialist topic not included in the the scope of the RRSR.

Specifically, the Guidelines provide within a single document, recommendations and material for potential inclusion in future editions of the national maintenance handbooks regarding:

- Maintenance procedures for an agreed list of paving types,
- Draft Cost Norms to cover the above procedures,
- Clear illustrated step-by step descriptions of maintenance procedures,
- Advice and comment on the links between condition monitoring and consequent maintenance programmes.



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## ABBREVIATIONS

| | |
|---|---|
| ADT | Average Daily Traffic |
| ARRB | Australian Road Research Board |
| ASEAN | Association of South East Asian Nations |
| Bmb | Bamboo |
| BRC | Bamboo Reinforced Concrete |
| CAFEO | Conference of ASEAN Federation of Engineering Organisations |
| CBR | California Bearing Ratio |
| CSIR | Council for Scientific and Industrial Research (South Africa) |
| DCP | Dynamic Cone Penetrometer |
| DFID | Department for International Development |
| DST | Department of Science and Technology, Ministry of Transport |
| DVD | Digital Video Disk |
| EDCs | Economically emerging and Developing Countries |
| esa | equivalent standard axles |
| FHWA | Federal Highways Association (US) |
| FM | Fines Modulus |
| FWD | Falling Weight Deflectometer |
| GMSARN | Greater Mekong Subregion Academic and Research Network |
| HDM4 | Highway Development and Management Model |
| HQ | Headquarters |
| IFG | International Focus Group |
| ILO | International Labour Organisation |
| IRI | International Roughness Index |
| ITST | Institute of Transport Science and Technology |
| Km | kilometre |
| LCS | Low Cost Surfacing |
| M | metre |
| MERLIN | **M**achine for **E**valuating **R**oughness using **L**ow-cost **IN**strumentation |
| MoT | Ministry of Transport |
| OM | Operations Manual |
| PCU | Passenger Car Unit |
| PDoT | Provincial Department of Transport |
| PIARC | World Road Association |
| PMU | Project Management Unit |
| PPC | Provincial Peoples Committee |
| PPMU | Provincial Project Management Unit |
| QA | Quality Assurance |
| RITST | Research Institute of Transportation Science & Technology |
| RRGAP | Rural Road Gravel Assessment Programme |
| RRSR | Rural Road Surfacing Research |
| RRST | Rural Road Surfacing Trials |
| RTU | Rural Transport Unit |
| RT1 | Rural Transport 1st Project |
| RT2 | Rural Transport 2nd Project |
| RT3 | Rural Transport 3rd Project |
| SEACAP | South East Asia Community Access Programme |
| SOE | State Owned Enterprise |
| TG | Technical Guidelines |
| TRL | Transport Research Laboratory |
| VOCs | Vehicle Operating Costs |
| VPD | Vehicles per day |
| WAN | Wide Area Network |
| WLC | Whole Life Costs |

# 1. INTRODUCTION

All components of the rural road infrastructure, such as running surface, shoulders, earthworks, bridges and drainage structures, require maintenance to ensure that they continue to function as intended and designed.

Traffic and the environment, particularly water, cause all road infrastructure to deteriorate over time. Even high quality works require some maintenance after construction and at times through the road's serviceable life. The maintenance requirements of "low cost" rural roads are relatively high, particularly for unsealed surfaces such as gravel. It is particularly vital that the maintenance of such roads is carried out to prevent the road reverting to a poor "earth" standard.

It is important that the maintenance of all types of rural road surface is provided in a timely way. If minor defects are repaired promptly, then road service life will be prolonged and the considerable investment will be protected. If the roads are not maintained, they may quickly deteriorate and it will be much more expensive to rehabilitate them later.

Badly maintained roads also cause additional costs to the users and community in higher vehicle operating and transport costs, reduced safety and delayed or slower journeys. Government, community, commercial and individual efforts to bring development and services to the rural areas will be hampered by poor road maintenance, and investments will be placed at risk.

**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.**

Vietnamese experience shows that without proper maintenance, rehabilitation costs will typically 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 preserves the 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 should raise their awareness and take actions to develop local road maintenance initiatives to match local requirements.

These Guidelines incorporate the requirements and recommendations of the State's Ordinance & documents for effective maintenance & management of rural roads.

## 2. WHAT NEEDS TO BE MAINTAINED?

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

(These diagrams are not drawn to scale)

FIGURE 1. TYPICAL CROSS-SECTION OF ROADS

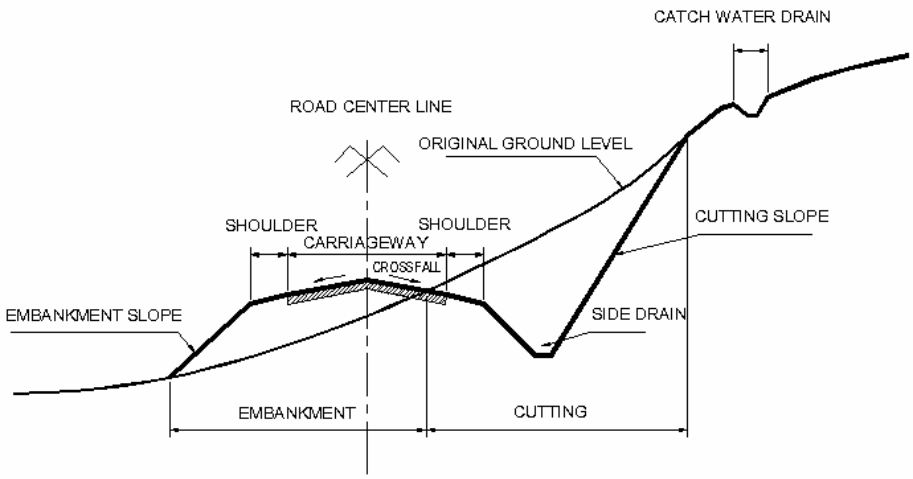



FIGURE 2. MAIN FEATURES OF CULVERTS

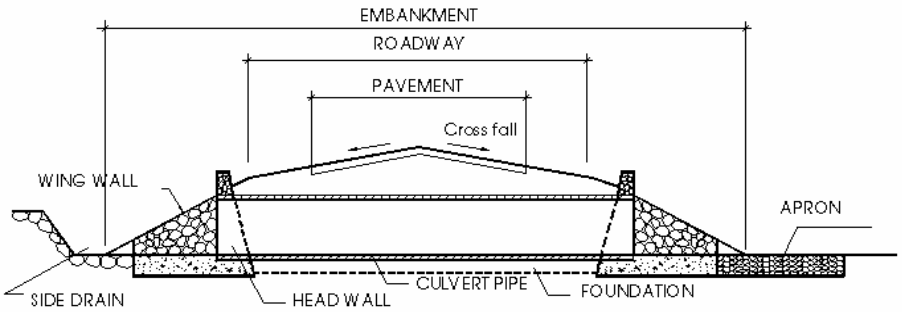


FIGURE 3. MAIN FEATURES OF BRIDGES

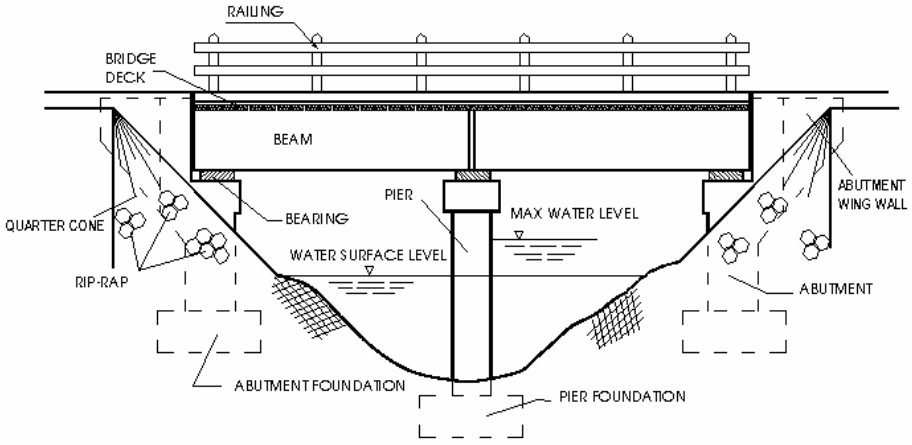



FIGURE 4. MAIN FEATURES OF THE DRAINAGE SYSTEM

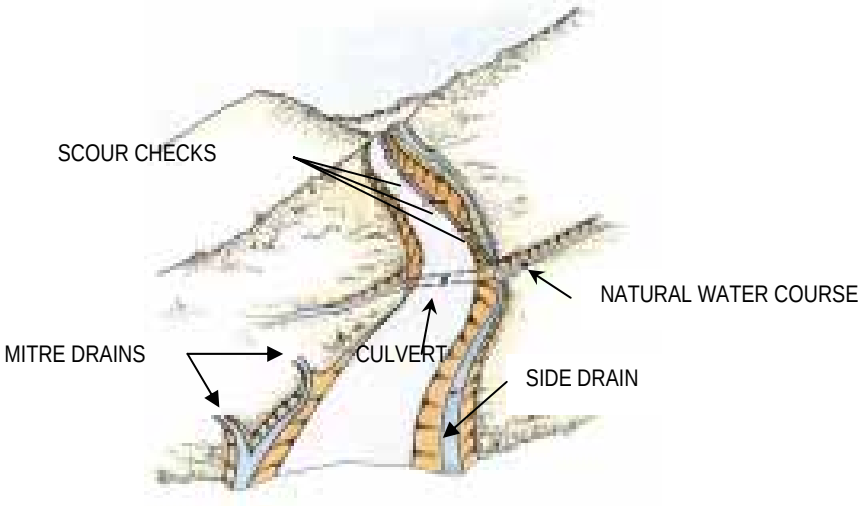


FIGURE 5 – ROAD RESERVE


Road Reserve (right of way) of inter village road and inter commune roads is regulated by the PPC

# 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, and 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.

The Guidelines in this document focus on the maintenance of the road surface, shoulders and road side areas.

## 3. EXISTING MAINTENANCE GUIDELINES

Existing guidance on rural road maintenance that complements this document is contained in the following documentation:-

- Rural Road Maintenance Handbook (For Commune Level), Transport Publishing House, MoT, Ha Noi, 2003.
- Technical Standards – Road Routine Maintenance, 22 TCN 306-03, MoT, 2003
- International Road Maintenance Handbook, PIARC, 1994.
- Road Maintenance, Repair and Management - Training Materials, MoT, 1993.

## 4. FORMAT OF THIS DOCUMENT

This document is structured as follows:-

MAINTENANCE TECHNIQUES for:

- ❑ Cement Concrete Pavement (Un-reinforced, Bamboo or Steel Reinforced)
- ❑ Bituminous Sand and Stone Chip Seals
- ❑ Fired Clay Brick, Concrete Brick or Stone Block Paving
- ❑ Road Base Repairs
- ❑ Penetration Macadam
- ❑ Unsealed WBM
- ❑ Unsealed Natural Gravel
- ❑ Shoulders

DRAFT COST NORMS

Appendices of supporting information.

# 5. MAINTENANCE TECHNIQUES

In Section 7 of this document, each maintenance technique is described with the following format:-

WORK PLANNING

- Activity Definition
- Activity Code
- Unit of Measurement
- Intervention Criteria
- Equipment required
- Materials required
- Personnel required
- Operational Issues

WORK METHOD

- Restoration Standard
- Operation Steps
- Check Points
- Notes

## 6. INDEX OF MAINTENANCE ACTIVITIES

CEMENT CONCRETE SLAB SURFACE (Un-reinforced, Bamboo or Steel Reinforced)

- C1 Contraction & Expansion Joint Repair
- C2 Surface Repair
- C3 Crack Repair
- C4 Edge Repair
- C5 Re-construct Slab

BITUMINOUS SAND & CHIP SEAL SURFACE

- BS1 Surface Bleeding Repair
- BS2 Individual Crack Repair
- BS3 Multiple Crack Repair
- BS4 Stripping Repair
- BS5 Pothole Repair

BURNT CLAY, CONCRETE OR STONE BRICK OR BLOCK SURFACE

- BB1 Repair damaged bricks, blocks or joints
- BB2 Replace damaged or missing bricks or blocks
- BB3 Replace or top up missing sand infill to joints

ROAD BASE OR SUB BASE

- RB1 Road Base Repair

PENETRATION MACADAM SURFACE

- PM1 Pothole Repair

WATER BOUND MACADAM SURFACE

- WB1 Pothole Repair

UNSEALED GRAVEL SURFACE

- GR1 Pothole Repair
- GR2 Remove Corrugations
- GR3 Grading/Reshaping
- GR4 Re-Gravelling
- GR5 Repair Soft Spot

SHOULDERS

- SH1 Unsealed Shoulder Repair
- SH2 Sealed Shoulder Repair

# 7. MAINTENANCE ACTIVITY STATEMENTS

| **Maintenance Activity Statement** | **C1** |
|---|---|

**WORK PLANNING**

**Contraction and Expansion Joint Repair** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

| | |
|---|---|
| **ACTIVITY DEFINITION** | All the surface joints of a concrete pavement should be fully infilled with bituminous sand joint compound. |
| **UNIT OF MEASUREMENT** | Linear Metre. |
| **INTERVENTION CRITERIA** | During service, joint seal materials can be aged becoming brittle and may crack. The seal may also be damaged by traffic. This would enable water penetration into the base layer and the risk of slab movement and settlement. Defect should be identified during annual inspection. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Heating equipment for bitumen.<br>Flattened steel bar. | The seal compound can be produced by mixing 60% bitumen and 40% sand by volume. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. poor construction quality, traffic damage, and aging)?<br>4. Has the slab moved or settled? If yes, plan and schedule another activity to correct that major defect (C5).<br>5. Are there any other related defects? (e.g. Cracks)<br>6. Specify and organise appropriate handtools, materials and staff. | |

**Maintenance Activity Statement** **C1**

**Contraction and Expansion Joint Repairs** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

## WORK METHOD

| **RESTORATION STANDARD** | The seal compound should fully infill the joints and be compacted. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control. | ▪ From Supervisor's instructions.<br>▪ Traffic control devices. | |
| 3. Remove any chippings stuck in the joints. | | |
| 4. Remove the damaged, or aged and hardened (inelastic) compound. | | |
| 5. Clean any dust or debris in the joint. | | |
| 6. Carefully heat the bitumen to the correct temperature (do not overheat) and mix the sand in the correct proportions. | ▪ Labourers using heated bitumen should be adequately trained in safe use of heated material and wear suitable protective clothing. | |
| 7. Fill new sand-bitumen seal compound into the joints. The seal compound should fully infill the joints and be finished level with the road surface. Cover the finished joint repair with clean sand. | ▪ The joint mix may be compacted into the joint by a flattened steel bar to achieve final seal level.<br>▪ It may be necessary to work on one half of the joint at a time to allow traffic flow. | |
| 8. When joint material has cooled, allow traffic to resume. | | |
| 9. Leave work site safe and tidy. | ▪ Clean/repair as necessary. | |
| 10. Remove traffic control. | | |

Damage.

Repaired.

**Maintenance Activity Statement** **C2**

**Surface Repair** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Repair the surface damage of cement concrete pavement. |
| **UNIT OF MEASUREMENT** | Square Metre. |
| **INTERVENTION CRITERIA** | Any concrete pavement surface damage likely to cause accident or injury to road user, e.g. spalling, pothole, loss of aggregate etc. Defect should be identified during annual inspection. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Broom. | Cement sand mortar<br>or<br>Cement concrete. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. overloaded vehicles, poor construction quality etc.)?<br>4. Has the slab moved or settled? If yes, plan and schedule another activity to correct that major defect (C5).<br>5. Are there any other related defects? (e.g. Cracks).<br>6. Specify and organise appropriate handtools, materials and staff. | |

Surface Spalling

Completed Cement Concrete Pavement

| **Maintenance Activity Statement** | **C2** |
|---|---|

**Surface Repair** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

## WORK METHOD

| **RESTORATION STANDARD** | Surface restored to durable surface level with surrounding slab. Good adhesion between new material and old surface. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control. | ▪ From Supervisor's instructions.<br>▪ Traffic control devices. | |
| 3. Use a hammer and chisel to remove any weak, friable or loose material. Broom or clean any loose material and then dry the damaged area. | ▪ Surface roughness creation will improve adhesion of the repair to the original concrete. | |
| 4. If the maximum depth of damaged area is less than 5cm, cement sand mortar may be used for pavement patching, provided that mortar should be at the same grade as the pavement concrete. If the maximum depth of damaged area is over 5cm and the area is larger than 300cm$^2$, cement concrete should be used for pavement patching with the similar requirements on grade. | ▪ Concrete or cement sand mortar shall be produced with the required design grade. | |
| 5. Before patching, the cleaned surface should be painted with a cement and water paste to ensure a good bond. Alternatively a resin bonding glue may be used. | | |
| 6. For repairs more than 5cm deep the fresh concrete of the same grade shall be laid into the broken area and then compacted until the required final level is achieved. | | |
| 7. The repair shall be screeded and trowelled level with the surrounding slab. Light grooving should be applied laterally across the finished repair with a suitable tool to improve tyre adhesion in service. | | |
| 8. Rapid setting additives can be used to minimise hindrance to the traffic flow. | ▪ In case no additive is used, normal traffic will be permitted after 14 days. | |
| 9. Once set, the repair should be cured with water and sand/sacking (and kept moist) and protected until the repair has gained sufficient strength (7 days with no rapid setting additive). | | |
| 10. Leave work site safe and tidy. | ▪ Clean/repair as necessary. | |
| 11. Remove traffic control. | | |

**Maintenance Activity Statement C3**

**Crack Repairs** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Repair the cracks of cement concrete pavement . |
| **UNIT OF MEASUREMENT** | Square Metre. |
| **INTERVENTION CRITERIA** | Cracks may appear in the concrete surface due to shrinkage, settlement or overloading. These need to be sealed to prevent water penetration into the base layer and the risk of consequent slab movement and failure. Defect should be identified during annual inspection. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Heating equipment for bitumen. | bitumen of 60/70 pen<br>kerosene<br>coarse sand, fine stone<br>or<br>bituminous sealant. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. shrinkage due to concrete too wet when laid, weak road base, ineffective side drains etc.)?<br>4. Has the slab moved or settled? If yes, plan and schedule another activity to correct that major defect (C5).<br>5. Are there any other related defects? (e.g. Surface damage). Any instigating defects (such as poor drainage) should also be repaired.<br>6. Specify and organise appropriate handtools, materials and staff. | |

**Maintenance Activity Statement C3**

**Crack Repairs** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

## WORK METHOD

| **RESTORATION STANDARD** | Cracks should be completely sealed to prevent water penetrating the concrete. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control. | ▪ From Supervisor's instructions.<br>▪ Traffic control devices. | |
| 3. Remove any broken or loose concrete with a hammer and chisel. Clean the cracks by taking out all the loose dust and chippings, then clean the surface around the cracks. | | |
| 4. If there are many small cracks with the widths ≤ 5mm, pure bitumen of 60/70 pen thinned with kerosene and then heated will be applied. The kerosene/bitumen rate will be 25/75 by weight. The heated cut-back will be poured into the cracks at a temperature of 70-80°C. The bitumen should extend 50mm either side of the crack. Coarse sand or fine crushed stone shall be added. | ▪ To produce workable "cutback" bitumen, use a mixing rate of kerosene to bitumen: 25/75.<br>▪ Labourers using heated bitumen should be adequately trained in safe use of heated material and wear suitable protective clothing. | |
| 5. In case the crack widths are > 5mm, clean the cracks and infill these with bituminous sealant as for contraction joint repairs (Activity C1). | | |
| 6. Leave work site safe and tidy. | ▪ Clean/repair as necessary. | |
| 7. Remove traffic control. | | |

Cracked Concrete Pavement

Repaired Pavement

**Maintenance Activity Statement C4**

**Edge Break Repairs** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

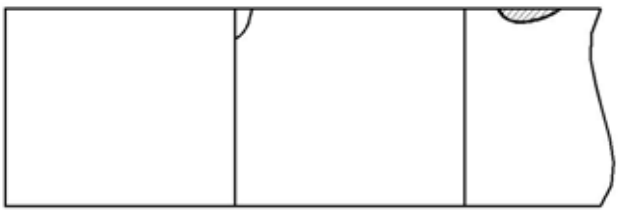
**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Repair the Edge Break of cement concrete pavement. |
| **UNIT OF MEASUREMENT** | Square Metre. |
| **INTERVENTION CRITERIA** | Repairs should be carried out whenever there appear edge breaks on the pavement. Defect should be identified during annual inspection. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Pneumatic breaker or hammers and chisels.<br>Broom.<br>Small Compactor.<br>Formwork. | Cement concrete or asphalt concrete.<br>moisture membrane.<br>reinforcement (if necessary). | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. overloaded vehicles weak road base, shoulder damage etc.)?<br>4. Has the slab moved or settled? If yes, plan and schedule another activity to correct that major defect (C5).<br>5. Are there any other related defects? (e.g. Surface damage). Any instigating defects (such as poor drainage or damaged shoulder) should also be repaired.<br>6. Specify and organise appropriate handtools, materials and staff. | |

Edge Break



Some Typical Edge Breaks

**Maintenance Activity Statement** **C4**

**Edge Break Repairs** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

**WORK METHOD**

| **RESTORATION STANDARD** | Good quality repair and adhesion between new material and old surface. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control.<br>3. Break out area of edge failure down to road base level with pneumatic breaker or hammers and chisels. Roughen concrete break face to ensure a good bond for the new material.<br>4. Replace any poor or wet road base material with specification quality material. Moisten and compact the base with a small compactor or hand rammer. If excessive moisture or standing water is encountered, take permanent measures to drain this away.<br>5. Remove any debris and loose material then dry the break face area. Place a 0.5mm thickness moisture membrane over the road base material to avoid moisture loss from the placed wet concrete.<br>6. Any reinforcement should be cleaned off, or replaced with 6mm reinforcing rod or mesh if necessary.<br>7. Fix any formwork necessary to cast the correct shape and level of concrete.<br>8. Before placing the new slab material, the cleaned slab break face should be painted with a cement and water paste to ensure a good bond. Alternatively a resin bonding glue may be used.<br>9. Cement concrete with the required design grade should be used for pavement patching. The concrete shall be placed in two layers each tamped thoroughly with a steel rod, and mixed at the interface.<br>10. The repair shall be screeded and trowelled level with the surrounding slab. Light grooving should be applied laterally across the finished repair with a suitable tool to improve tyre adhesion in service.<br>11. Once set, the repair should be cured with water and sand/sacking (and kept moist) and protected until the repair has gained sufficient strength (7 days with rapid setting additive).<br>12. Leave work site safe and tidy.<br>13. Remove traffic control. | ▪ From Supervisor's instructions.<br>▪ Traffic control devices.<br>▪ At the discretion of the Engineer, steel nails or pins may be specified and inserted in the break face to improve the bond with the new concrete.<br>▪ Asphalt concrete can be used instead of cement concrete. In this case the break face is to be painted with bitumen emulsion and allowed to dry before placing the asphalt mix material. Every 5cm concrete asphalt is also laid into the broken area and then compacted by hand using a compactor. Traffic can be permitted right after repair completion.<br>▪ In case no cement concrete additive is used, normal traffic will be permitted after 14 days.<br>Clean/repair as necessary. | |

**Maintenance Activity Statement** **C5**

**Re-construct Slab** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Replace severely damaged concrete pavement slab. |
| **UNIT OF MEASUREMENT** | Square Metre of (the specified type of) concrete paving and Square Metre of shoulder. |
| **INTERVENTION CRITERIA** | Where the slab has been severely cracked, has settled, moves under traffic or there is a step at the joint likely to cause accident or injury to road user, the complete slab should be considered for replacement. This is a high cost operation and should be carefully planned and the necessary resources secured. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Pneumatic breaker or sledgehammers, crowbars, hammers and chisels.<br>Broom.<br>Small Compactor.<br>Formwork. | 6mm reinforcement steel mesh.<br>cement concrete.<br>moisture membrane. | Foreman 1<br>Labourers 3-4<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. overloaded vehicles weak road base, shoulder damage, etc.)?<br>4. Are there any instigating defects (such as poor drainage or damaged joints) that should also be repaired.<br>5. Specify and organise appropriate handtools, materials and staff. | |

Severely Damaged Concrete Pavement

**Maintenance Activity Statement** **C5**

**Re-construct Slab** (Un-reinforced, Bamboo and Steel Reinforced Cement Concrete Pavement).

**WORK METHOD**

| **RESTORATION STANDARD** | Re-construct the slab to the construction design specifications and standards. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control.<br>3. Break out area of defective slab down to road base level with pneumatic breaker or sledge hammers, cowbars, hammers and chisels.<br>4. Replace any poor or wet road base, sub base and sub grade material with specification quality material (RB1). Moisten and compact the repairs with a small compactor. If excessive moisture or standing water is encountered, take permanent measures to drain this away.<br>5. Fix the side formwork in place.<br>6. Remove any debris and loose material. Place a 0.5mm thickness moisture membrane over the road base material to avoid moisture loss from the placed wet concrete.<br>7. Joint dowels should be cleaned off. A new layer of specified reinforcement should be placed and blocked to the correct level.<br>8. Cement concrete with the required design grade should be used for the replacement slab.<br>9. The concrete shall be placed in a continuous operation and vibrated thoroughly, tamped and screeded to the correct falls and levels.<br>10. Light grooving should be applied laterally across the finished slab before the concrete sets with a suitable tool to improve tyre adhesion in service.<br>14. Once set, the slab should be cured with water and sand/sacking (and kept moist) and protected until the slab has gained sufficient strength (7 days with no rapid setting additive).<br>15. Re-construct the shoulders.<br>16. Leave work site safe and tidy.<br>17. Remove traffic control. | ▪ From Supervisor's instructions.<br>▪ Traffic control devices.<br><br>▪ In case no cement concrete additive is used, normal traffic will be permitted after 14 days.<br>▪ Clean/repair as necessary. | |

**Maintenance Activity Statements** **BS1**

**Surface Bleeding Repair** (Bituminous Sand & Chip Seal Pavement).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Bituminous Pavement Bleeding Repair. |
| **UNIT OF MEASUREMENT** | Square Metre. |
| **INTERVENTION CRITERIA** | In hot weather, the pavement temperature can reach 60-70$^{o}$C. Excess bitumen may rise to the pavement surface and this can result in stripping by traffic or a cause slippery surface when wet. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools. | coarse sand<br>or<br>fine stone. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects ( e.g. excess bitumen, unusually high temperatures, heavy traffic?) Schedule another activity to correct this if needed.<br>4. Are there any other related defects? (Cracks).<br>5. Specify and organise appropriate handtools, material and staff. | |

**Maintenance Activity Statements** **BS1**

**Surface Bleeding Repair**
(Bituminous Sand & Chip Seal Pavement).

**WORK METHOD**

| **RESTORATION STANDARD** | No bituminous bleeding on the road surface. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control. | ▪ from Supervisor's instructions.<br>▪ Traffic control devices. | |
| 3. Spread coarse sand or stone fines (powder content ≤ 10%) over the pavement in a high temperature period (e.g. 11am - 2pm) for optimum effect. | | |
| 4. Collect dispersed sand and chippings and re-deposit on bleeding areas until cured. | | |
| 5. Leave work site safe and tidy. | - Clean/repair as necessary. | |
| 6. Remove traffic control. | | |

Bituminous Pavement Bleeding

**Maintenance Activity Statements** **BS2**

**WORK PLANNING**

**Invidual Crack Repairs** (Bituminous Sand & Chip Seal Pavement).

| | |
|---|---|
| **ACTIVITY DEFINITION** | Repairing the Individual Crack of sand or chip seal surface (> 1mm wide cracks). |
| **UNIT OF MEASUREMENT** | Metre. |
| **INTERVENTION CRITERIA** | Cracks may appear due to a number of causes including; aging of the bitumen, poor or variable construction quality, moisture entry into the base, movement in the base material, or the pavement is not strong enough for the traffic loading. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Hammer and Chisel. | rapid setting cationic emulsion<br>or<br>heated bitumen.<br>coarse sand or stone fines. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. pavement structure strength is not strong enough etc.)? Schedule another activity to correct this if needed.<br>4. Are there any other related defects? (potholes).<br>5. Specify and organise appropriate handtools, material and staff. | |

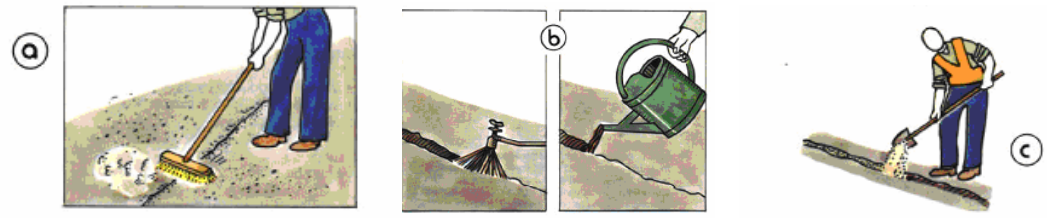
**Maintenance Activity Statements** **BS2**

**Invidual Crack Repairs**
(Bituminous Sand & Chip Seal Pavement).

**WORK METHOD**

| **RESTORATION STANDARD** | The sand bitumen covers the cracks on the surface. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control.<br>3. Chisel to enlarge the cracks into the wedge shape.<br>4. Remove all the loose materials.<br>5. Spray or pour rapid setting cationic emulsion or heated bitumen into the cracks.<br>6. Spread sand on the top.<br>7. For the deeper cracks, the procedure shall be done twice.<br>8. Leave work site safe and tidy.<br>9. Remove traffic control. | ▪ from Supervisor's instructions.<br>▪ Traffic control devices.<br><br>- Clean/repair as necessary. | |




Initial Crack Repair Procedures

**Maintenance Activity Statements** **BS3**

**Multiple Crack Repair** (Bituminous Sand & Chip Seal Pavement).

## WORK PLANNING

| | |
|---|---|
| **ACTIVITY DEFINITION** | Repairing the Multiple Cracks of sand & chip seal pavement (<1mm wide cracks). |
| **UNIT OF MEASUREMENT** | Square Metre. |
| **INTERVENTION CRITERIA** | Cracks may appear due to a number of causes including; aging of the bitumen, poor or variable construction quality, moisture entry into the base, movement in the base material, or the pavement is not strong enough for the traffic loading. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools. | coarse sand.<br>emulsion. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. pavement structure strength is not strong enough etc.)? Schedule another activity to correct this if needed.<br>4. Are there any other related defects? (potholes).<br>5. Specify and organise appropriate handtools, material and staff. | |

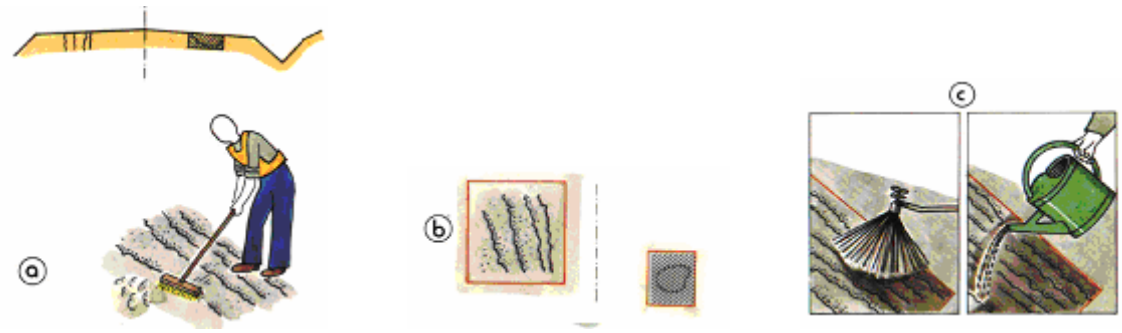
**Maintenance Activity Statements** **BS3**

**Multiple Crack Repair** (Bituminous Sand & Chip Seal Pavement).

## WORK METHOD

| **RESTORATION STANDARD** | Cracks no longer visible on the surface. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control. | ▪ from Supervisor's instructions.<br>▪ Traffic control devices. | |
| 3. Mark and clean the crazing areas. | | |
| 4. Produce bituminous slurry of coarse sand and emulsion. | - The rate of 20 litres and 6 litres respectively. | |
| 5. Lay a thin slurry layer within the crazing area with the thickness of about 5mm. | | |
| 6. Blind the area of repair with coarse sand or stone fines. | | |
| 7. Wait for the slurry to dry out and set before allowing traffic to resume. | | |
| 8. Leave work site safe and tidy. | - Clean/repair as necessary. | |
| 9. Remove traffic control. | | |




Multiple Crack Repair Procedures

**Maintenance Activity Statements** **BS4**

**Stripping Repair** (Bituminous Sand & Chip Seal Pavement).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Local Pavement Stripping Repair. |
| **UNIT OF MEASUREMENT** | Square Metre. |
| **INTERVENTION CRITERIA** | During the operational service, there may be some local pavement stripping due to the poor construction quality, aged bituminous pavement or overloaded vehicle inducement. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>1 Ton deadweight roller. | rapid setting cationic emulsion.<br>6-10mm stone chippings. | Foreman 1<br>Labourers 1-2<br>Driver (roller) 1<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. overloaded vehicle etc.)? Schedule another activity to correct this if needed.<br>4. Check for services (e.g. overhead wires).<br>5. Are there any other related defects? (potholes).<br>6. Specify and organise appropriate handtools, material and staff. | |

Local Pavement Stripping

**Maintenance Activity Statements** **BS4**

**Stripping Repair** (Bituminous Sand & Chip Seal Pavement).

## WORK METHOD

| **RESTORATION STANDARD** | There is not any pavement stripping on the surface. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control.<br>3. Mark the damaged area, remove the stone stripping areas and clean away any dust.<br>4. Spray rapid setting cationic emulsion.<br>5. Spread 6-10mm stone chippings.<br>6. Use a 1 ton deadweight roller for compaction.<br>7. Add crushed stone manually for the deficient areas if needed.<br>8. Seal the second layer if needed.<br>9. Leave work site safe and tidy.<br>10. Remove traffic control. | ▪ from Supervisor's instructions.<br>▪ Traffic control devices.<br>▪ with the rate of 1.8 litres/ m2.<br>▪ Overlap the new bitumen seal at least 100mm onto the existing seal.<br>▪ with 4-6 passes/point.<br>- Clean/repair as necessary. | |

**Maintenance Activity Statements** **BS5**

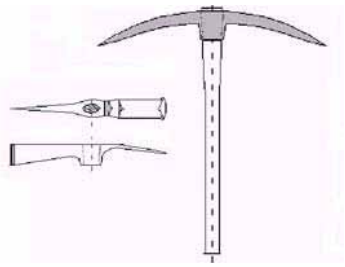
**Pothole Repair** (Bituminous Sand & Chip Seal Pavement).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Pothole Patching. |
| **UNIT OF MEASUREMENT** | Square Metre. |
| **INTERVENTION CRITERIA** | When potholes appear, they should be repaired as soon as possible. If not, then the damaged areas could increase to result in more costly repairs being required. Potholes are also a particular danger for road users, especially at night. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>pick axe, crow bar.<br>jumping plate compactor or 1T vibrating roller. | chippings.<br>cut-back.<br>fine stone (2-5mm).<br>fine gravel or coarse sand. | Foreman 1<br>Labourers 1-2<br>Driver (roller) 1<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. moisture in road base, overloaded vehicle etc.)? Schedule another activity to correct this if needed.<br>4. Check for services (e.g. overhead wires).<br>5. Are there any other related defects? (cracks).<br>6. Specify and organise appropriate handtools, material and staff. | |



Pick axe

Jumping Plate Compactor

**Maintenance Activity Statements** **BS5**

**Pothole Repair** (Bituminous Sand & Chip Seal Pavement).

**WORK METHOD**

| **RESTORATION STANDARD** | Level of pothole surface is not higher than road surface 1cm. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control.<br>3. Use pick axe and crow bar to form the potholes into a regular shape, then dig down to the bottom of the damaged areas.<br>4. Remove all the loose materials and clean away any dust.<br>5. Place mix of chippings and cut-back into the damaged areas to achieve the loose level higher than the previous pavement.<br>6. Spread fine stone (2-5mm), fine gravel or coarse sand over the mix for anti-tyre adhesion.<br>7. Use a jumping plate compactor for compaction or use a 1T vibrating roller for compaction.<br>8. Leave work site safe and tidy.<br>9. Remove traffic control. | ▪ from Supervisor's instructions.<br>▪ Traffic control devices.<br>▪ Excavate until dry material is found. If moisture persists, this may be the cause of the defect and specific measures may be needed to drain the area, otherwise the defect will recur.<br>▪ Compaction ratio of 1.4<br>▪ The rate of 4-5 litre/m2.<br>▪ plate compactor: 6-8 passes/point.<br>▪ roller: 3-4 passes/point and speed of 1.5-2 km/h.<br>▪ Clean/repair as necessary. | |

Pothole in a Bituminous Chip Seal

**Maintenance Activity Statements** **BB1**

**Repair damaged brick, or block joints** (Fired clay, concrete or stone brick or block pavement).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Infill damaged or cracked mortar joints on carriageway or edge bricks and repair minor brick or block damage. |
| **UNIT OF MEASUREMENT** | Metre. |
| **INTERVENTION CRITERIA** | During the operational service, individual blocks my suffer surface deterioration, the mortar joints may crack or strip because of heavy vehicle impacts, poor quality construction or weak sub-grade. The damaged bricks/blocks mortar joints should be repaired immediately to avoid any further pavement deterioration. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Hammer and Chisel.<br>Trowel. | Cement mortar grade 75. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. heavy vehicle impacts or weak sub-grade)? Schedule another activity to correct this if needed.<br>4. Are there any other related defects? (eg broken bricks).<br>5. Specify and organise appropriate handtools, material and staff. | |

Cracks in Brick Joints

**Maintenance Activity Statements** **BB1**

**Repair damaged brick, or block joints** (Fired clay, concrete or stone brick or block pavement).

**WORK METHOD**

| **RESTORATION STANDARD** | After being infilled, the mortar joints must be at the same level with the pavement surface. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control. | ▪ from Supervisor's instructions.<br>▪ Traffic control devices. | |
| 3. Use a chisel to take out any damaged mortar joints then clean dust in the cracks. | | |
| 4. Dampen the surfaces to be repaired. | - Mortar grade 75: refer to Appendix 3. | |
| 5. Infill cement mortar grade 75 into the damaged surface of the bricks/blocks and damaged joints between bricks. Use a trowel to achieve the full depth of damaged joints infilled. | | |
| 6. After being infilled, the mortar joints must be at the same level with the pavement. | - Clean/repair as necessary. | |
| 7. Leave work site safe and tidy. | | |
| 8. Remove traffic control. | | |

Edge Brick Repair

Repaired Mortar Joint

**Maintenance Activity Statements** **BB2**

**Replace damaged or missing bricks or blocks** (Fired clay, concrete or stone brick or block pavement).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Remove and replace sunken broken or damaged bricks. |
| **UNIT OF MEASUREMENT** | Square Metre. |
| **INTERVENTION CRITERIA** | Some bricks may be broken or crushed under heavy vehicles or due to weak strength (under-fired bricks) or may have settled locally due to base movement. All the damaged and broken bricks should be replaced. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Hammer and Chisel.<br>Trowel. | Cement mortar.<br>Bricks, blocks or stones. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. bricks may be broken or crushed under heavy vehicles or due to weak strength)? Schedule another activity to correct this if needed.<br>4. Are there any other related defects? (cracked mortar joints).<br>5. Specify and organise appropriate handtools, material and staff. | |

Damaged Bricks

| **Maintenance Activity Statements** | **BB2** |
|---|---|

**Replace damaged or missing bricks or blocks** (Fired clay, concrete or stone brick or block pavement).

## WORK METHOD

| **RESTORATION STANDARD** | After being replaced, the bricks/blocks and mortar joints must be at the same level with the surrounding pavement surface. |
|---|---|

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control.<br>3. Use chisel to enlarge the mortar joints around the damaged bricks/blocks. Carefully take out the whole damaged bricks/blocks.<br>4. Trim the opening to obtain a regular r shape, then clean any loose mortar and dust.<br>5. Select bricks/blocks with the same dimensions and specified quality for replacement.<br>6. Infill mortar and then lay in the new bricks/blocks and tap them into final position with a mason's hammer. Infill mortar with a trowel to create an even surface.<br>7. Leave work site safe and tidy.<br>8. Remove traffic control. | ▪ from Supervisor's instructions.<br>▪ Traffic control devices.<br><br>▪ Ensure that the replacement brick/block is well bedded and will not settle in service.<br>▪ Mortar grade: refer to Appendix 3.<br>▪ Clean/repair as necessary. | |


Brick Road in Viet Nam

**Maintenance Activity Statements** **BB3**

**Replace or top up missing sand infill to joints** (Fired clay, concrete or stone brick or block pavement).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Replace missing sand infilled to joints. |
| **UNIT OF MEASUREMENT** | Metre. |
| **INTERVENTION CRITERIA** | During operational service, the stripping of the emulsion seal may result in joint material loss if no immediate repair is to be carried out. Before any sand emulsion seal repair, missing sand at the joints should be replaced. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Hammer and Chisel.<br>Trowel. | Sand.<br>Water. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (stripping emulsion seal)? Schedule another activity to correct this if needed.<br>4. Are there any other related defects (Sand seal replacement or repair)?<br>5. Specify and organise appropriate handtools, material and staff. | |

Missing Sand Infill to Joints

**Maintenance Activity Statements** **BB3**

**Replace or top up missing sand infill to joints** (Fired clay, concrete or stone brick or block pavement).

## WORK METHOD

| | |
|---|---|
| **RESTORATION STANDARD** | After being infilled, the sand joints must be at the same level with the top face of the paving bricks. |

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control.<br>3. Use a chisel to take out the damaged joints then clean any waste content.<br>4. Infill the joints between bricks with dry sand. Water then use a trowel to fill sufficient sand into the damaged joints.<br>5. After being infilled, the joints should be at the same level with the upper surface of the bricks.<br>6. Leave work site safe and tidy.<br>7. Remove traffic control. | ▪ from Supervisor's instructions.<br>▪ Traffic control devices.<br>▪ Slightly overfill the joints with sand so that the traffic will consolidate the fill material. Clean this surplus away before applying the new sand seal (Activity BS3).<br>▪ Clean/repair as necessary. | |

**Maintenance Activity Statements** **RB1**

**Road Base Repair**

(Dry Bound Macadam Pothole Repair).

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Dry Bound Macadam Pothole Infilling and Compaction. |
| **UNIT OF MEASUREMENT** | Cubic Metre. |
| **INTERVENTION CRITERIA** | Deeper potholes may require the road base to be repaired. Bases that are not cement or bitumen bound may be repaired with the Dry Bound Macadam technique. After the base repair the appropriate surface repair should be carried out. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Handtools.<br>Jumping plate compactor. | 40/60 stone chippings.<br>2/5mm fine stone.<br>Water. | Foreman 1<br>Labourers 1-2<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. overloaded vehicle etc.)? Schedule another activity to correct this if needed.<br>4. Are there any other related defects (Surface damages)?<br>5. Specify and organise appropriate handtools, material and staff. | |

**Maintenance Activity Statements** **RB1**

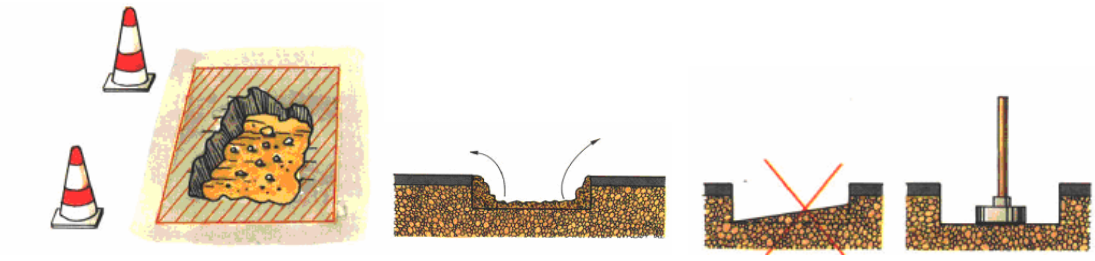
**Road Base Repair**

(Dry Bound Macadam Pothole Repair).

**WORK METHOD**

| | |
|---|---|
| **RESTORATION STANDARD** | The dry-bound macadam shall, on completion of compaction, be well closed, free from movement under the plate compactor and free from compaction planes, ridges, cracks or loose material. |

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control.<br>3. Trim the area of the pothole into a neat rectangular shape with vertical sides and minimum depth of 10cm.<br>4. Remove all the loose materials and dust from the damaged areas.<br>5. Place 40/60 stone chippings in layers of no more than 10cm compacted.<br>6. Each layer of coarse aggregate shall be shaped and compacted and then the well graded fine aggregate, passing the 5.0mm sieve, spread onto the surface, and rolled into the voids with a Jumping plate compactor to produce a dense layer. The blinding fines may need to be lightly watered to assist in the process. The base repair should be completed level with the top of the surrounding road base.<br>7. Leave work site safe and tidy.<br>8. Remove traffic control. | - from Supervisor's instructions.<br>- Traffic control devices.<br>- Excavate until dry material is found. If moisture persists, this may be the cause of the defect and specific measures may be needed to drain the area, otherwise the defect will recur.<br>- The compacted thickness of each layer should not exceed twice the nominal stone size.<br>- Clean/repair as necessary. | |



Pothole Repair Procedures

**FOR THE FOLLOWING MAINTENANCE ACTIVITIES PLEASE REFER TO THE EXISTING DOCUMENTATION AND GUIDELINES AS INDICATED.**

PENETRATION MACADAM SURFACE

PM1 Pothole Repair - Pursuant to Vietnamese maintenance procedures
(Technical Standards – Road Routine Maintenance, 22 TCN 306-03, MoT, 2003)

WATER BOUND MACADAM SURFACE

WB1 Pothole Repair - Pursuant to Vietnamese maintenance procedures
(Technical Standards – Road Routine Maintenance, 22 TCN 306-03, MoT, 2003)

UNSEALED GRAVEL SURFACE

GR1 Pothole Repair - Pursuant to Vietnamese maintenance procedures
(Rural Road Maintenance Handbook, MoT, 2003)

GR2 Remove Corrugations - Pursuant to Vietnamese maintenance procedures
(Rural Road Maintenance Handbook, MoT, 2003)

GR3 Grading/Reshaping - Pursuant to Vietnamese maintenance procedures
(Rural Road Maintenance Handbook, MoT, 2003)

GR4 Re-Gravelling - Pursuant to Vietnamese maintenance procedures
(Technical Standards – Road Routine Maintenance, 22 TCN 306-03, MoT, 2003)

GR5 Repair Soft Spot - Pursuant to Vietnamese maintenance procedures
(Rural Road Maintenance Handbook, MoT, 2003)

SHOULDERS

SH1 Unsealed Shoulder Repair (See next page)

SH2 Sealed Shoulder Repair – Refer to Activities BS1, BS2, BS3, BS4, BS5.

**Maintenance Activity Statements SH1**

**Unsealed Shoulder Repair.**

**WORK PLANNING**

| | |
|---|---|
| **ACTIVITY DEFINITION** | Replace eroded or damaged shoulder with stone chip stabilized local soil. |
| **UNIT OF MEASUREMENT** | Cubic Metre. |
| **INTERVENTION CRITERIA** | - If the shoulder does not provide lateral support for the road pavement, or does not fall away from the pavement surface at 5% ensuring drainage, timely repairs should be carried out. If a hard stone quarry is nearby, crushed stone stabilized in situ soil can be used for the shoulder repair.<br>- Shoulder repair activities are described in the Road Maintenance Handbook (Commune Level) – MOT, 2003. This Activity SH1 provides an acceptable alternative solution using crushed stone stabilized shoulders. |

| EQUIPMENT | MATERIALS | PERSONNEL |
|---|---|---|
| Hand tools.<br>Hoe.<br>1T roller or vibrating plate compactor. | 0.5x1 or<br>1x2cm crushed stone chippings.<br>Water. | Foreman 1<br>Labourers 1-2<br>Driver (Roller) 1<br>Traffic Controllers (as required). |

| OPERATIONAL ISSUES | NOTES |
|---|---|
| 1. Define the area for repair.<br>2. Check other maintenance or permanent works programmes for the area.<br>3. What caused the defects (e.g. vehicles, rain water etc.)? Schedule another activity to correct this if needed.<br>4. Check for services (e.g. overhead wires).<br>5. Are there any other related defects (land slide, erosion)?<br>6. Specify and organise appropriate handtools, material and staff. | |

**Maintenance Activity Statements** **SH1**

**Unsealed Shoulder Repair.**

## WORK METHOD

| | |
|---|---|
| **RESTORATION STANDARD** | 5-6% cross fall. The shoulder inside edge should be at the same level with the pavement outside edge. |

| STEPS | CHECK POINTS | NOTES |
|---|---|---|
| 1. Determine the work area.<br>2. Establish traffic control.<br>3. Use a hoe to remove any loose or soft material, mud, waste material and vegetation in the damaged areas to a minimum depth of 10cm.<br>4. Mix good quality, dry in situ soil with 20% 0.5x1 or 1x2cm crushed stone chippings. Water can be added to initiate material mixing and compaction activities.<br>5. Damp the areas to be filled. Place the above mentioned pre-mixed stabilized material into layers (maximum 10cm), then new material can be compacted until the final cross fall is achieved. One 1T roller will be used. The inside edge of shoulder should be at the same level with the outside edge of pavement.<br>6. Leave work site safe and tidy.<br>7. Remove traffic control. | - from Supervisor's instructions.<br>- Traffic control devices.<br><br>- cross fall 5-6%.<br>- with 6-8 passes/ point.<br>- If the shoulder is less than 75cm wide, a vibrating plater compactor should be used.<br>- Clean/repair as necessary. | |

Completed Shoulder

## Draft Maintenance Norm

| Ref | Activity | | | Unit | Total amount | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Material Norm | | | Labour Norm | | | Equipment Norm | | |
| | | | | | Materials | Unit | Amount | Labour | Unit | Amount | Equipment | Unit | Amount |
| **1** | **Concrete pavement** | | | | | | | | | | | | |
| C1 | Extension joints repair | | | m | Bitumen | kg | 0.282 | Level 4,0/7 | manday | 0.05 | | | |
| | | | | | Coarse sand | $m^3$ | 0.000161 | | | | | | |
| | | | | | Other materials | % | 5 | | | | | | |
| C2 | Repair pavement small defected (depth <5cm) | | | $m^3$ | Cement | kg | 435.67 | Level 4,0/7 | manday | 5.33 | | | |
| | | | | | Coarse sand | $m^3$ | 1.09 | | | | | | |
| | Repair pavement small defected (depth >5cm) | | | $m^3$ | Cement | kg | 350.55 | Level 4,0/7 | manday | 2.36 | Mix machine | shift | 0.095 |
| | | | | | Chipping 10-20mm | $m^3$ | 0.9 | | | | Pocker | shift | 0.089 |
| | | | | | Coarse sand | $m^3$ | 0.48 | | | | | | |
| | | | | | Water | $m^3$ | 189.63 | | | | | | |
| C3a | Repair cracks (crack width <5mm) | Width (mm) | Depth (cm) | | | | | | | | | | |
| | | 3 | 10 | m | Bitumen emulsion | kg | 0.589 | Level 4,0/7 | manday | 0.05 | | | |
| | | | | | Coarse sand | $m^3$ | 0.0002 | | | | | | |
| | | 3 | 5 | m | Bitumen emulsion | kg | 0.295 | Level 4,0/7 | manday | 0.05 | | | |
| | | | | | Coarse sand | $m^3$ | 0.0001 | | | | | | |
| | | 4 | 10 | m | Bitumen emulsion | kg | 0.785 | Level 4,0/7 | manday | 0.05 | | | |
| | | | | | Coarse sand | $m^3$ | 0.00027 | | | | | | |
| | | 4 | 5 | m | Bitumen emulsion | kg | 0.393 | Level 4,0/7 | manday | 0.05 | | | |
| | | | | | Coarse sand | $m^3$ | 0.000135 | | | | | | |
| C3b | Repair cracks (crack width >5mm) | 6 | 10 | m | Bitumen | kg | 0.706 | Level 4,0/7 | manday | 0.05 | | | |
| | | | | | Coarse sand | $m^3$ | 0.0004 | | | | | | |
| | | | | | Other materials | % | 5 | | | | | | |
| | | 6 | 5 | m | Bitumen | kg | 0.353 | Level 4,0/7 | manday | 0.05 | | | |
| | | | | | Coarse sand | $m^3$ | 0.0002 | | | | | | |
| | | | | | Other materials | % | 5 | | | | | | |
| | | 7 | 10 | m | Bitumen | kg | 0.824 | Level 4,0/7 | manday | 0.05 | | | |
| | | | | | Coarse sand | $m^3$ | 0.00047 | | | | | | |
| | | | | | Other materials | % | 5 | | | | | | |
| | | 7 | 5 | m | Bitumen | kg | 0.412 | Level 4,0/7 | manday | 0.05 | | | |
| | | | | | Coarse sand | $m^3$ | 0.000235 | | | | | | |
| | | | | | Other materials | % | 5 | | | | | | |
| C4 | Brocken edges (depth <5cm) | | | $m^3$ | Cement | kg | 435.67 | Level 4,0/7 | manday | 5.33 | | | |
| | | | | | Coarse sand | $m^3$ | 1.09 | | | | | | |
| | | | | | Form work | % | 5 | | | | | | |
| | Brocken edges (depth >5cm) | | | $m^3$ | Cement | kg | 350.55 | Level 4,0/7 | manday | 2.36 | Mix machine | shift | 0.095 |
| | | | | | Chipping 10-20mm | $m^3$ | 0.9 | | | | Pocker | shift | 0.089 |
| | | | | | Coarse sand | $m^3$ | 0.48 | | | | | | |
| | | | | | Water | $m^3$ | 189.63 | | | | | | |
| | | | | | Form work | % | 5 | | | | | | |

| Ref | Activity | Unit | Total amount | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Material Norm | | | Labour Norm | | | Equipment Norm | | |
| | | | Materials | Unit | Amount | Labour | Unit | Amount | Equipment | Unit | Amount |
| **2** | **Emulsion sand seal on emulsion chip seal** | | | | | | | | | | |
| S1 | Repair Sand seal erosion | $m^2$ | Emulsion seals CRS<br>Emulsion seals CSS<br>Coarse sand | kg<br>kg<br>$m^3$ | 1.926<br>0.642<br>0.0166 | Level 4,0/7 | manday | 0.0442 | 8.5T steel roller | shift | 0.0021 |
| S2 | Repair Chip seal erosion | $m^2$ | Emulsion seals CRS<br>Emulsion seals CSS<br>Stone 10mm | kg<br>kg<br>$m^3$ | 2.461<br>0.642<br>0.0166 | Level 4,0/7 | manday | 0.0442 | 8.5T steel roller | shift | 0.0021 |
| S3 | Repair Individual cracks (crack > 5mm) | m | Bitumen<br>Coarse sand<br>Other materials | kg<br>$m^3$<br>% | 0.141<br>0.00008<br>5 | Level 4,0/7 | manday | 0.05 | | | |
| S4 | Repair crocodile cracks | $m^2$ | Emulsion seals CRS<br>Emulsion seals CSS<br>Coarse sand<br>Stone 10mm | kg<br>kg<br>$m^3$<br>$m^3$ | 4.387<br>0.642<br>0.0166<br>0.0166 | Level 4,0/7 | manday | 0.0884 | 8.5T steel roller | shift | 0.0042 |
| PBR | Pavement Bleeding Resistance | $m^2$ | Coarse sand | $m^3$ | 0.002 | Level 3.5/7 | manday | 0.0025 | | | |
| **3** | **Dry Bound Macadam Road base** | | | | | | | | | | |
| DBM1 | Filling pothole | $m^3$ | Stone 40-60mm<br>Fine stone<5mm | $m^3$<br>$m^3$ | 1.319<br>0.466 | Level 2.7/7 | manday<br>*(Adjust labour cost from 2.92 to 2.5)* | 2.5 | Jumping plate compactor | shift | 0.033 |
| **4** | **Lime Stabilised Road base** | | | | | | | | | | |
| LSS | Filling pothole | $m^3$ | Local clayer soils<br>Powder lime 7%<br>Fine sand<br>Other materials | $m^3$<br>kg<br>$m^3$<br>% | 1.498<br>128<br>0.335<br>1 | Level 4,0/7 | manday<br>*(Adjust labour cost from 1.88 to 2.38)* | 2.38 | Jumping plate compactor | shift | 0.033 |
| **5** | **Fire clay bricks with cement mortared joint and cement mortared edge bricks** | | | | | | | | | | |
| BB1 | Cracked or missing mortar in joints on carriageway or edge bricks | $m^2$ | Cement<br>Coarse sand | kg<br>$m^3$ | 3.14<br>0.012 | Level 3.7/7 | manday | 0.3 | | | |
| BB2a | Broken or crushed bricks | $m^2$ | Cement<br>Coarse sand<br>Brick | kg<br>$m^3$<br>piece | 16.2<br>0.0595<br>81 | Level 3.5/7 | manday | 0.45 | | | |
| BB4a | Repair Depressed areas | $m^2$ | Cement<br>Coarse sand<br>Brick<br>Sand bedding | kg<br>$m^3$<br>piece<br>$m^3$ | 16.2<br>0.0595<br>16<br>0.061 | Level 3.5/7<br>- Labor cost for construction sand bedding layer is 0.026 (level3.5 | manday | 0.486 | 60kg vibrating plate copactor | shift | 0.00165 |

| Ref | Activity | Unit | Total amount | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Material Norm | | | Labour Norm | | | Equipment Norm | | |
| | | | Materials | Unit | Amount | Labour | Unit | Amount | Equipment | Unit | Amount |
| **6** | **Fired clay bricks with sand filled joints. Mortared edge bricks** | | | | | | | | | | |
| BB1 | | | | | | | | | | | |
| BB2b | Broken or crushed bricks | $m^2$ | Brick<br>Coarse sand | piece<br>$m^3$ | 81<br>0.026 | Level 3.5/7 | manday | 0.198 | 60kg vibrating plate copactor | shift | 0.005 |
| BB3 | Missing sand infill to joints | $m^2$ | Coarse sand | $m^3$ | 0.0104 | Level 3.5/7 | man-day | 0.03 | 60kg vibrating plate copactor | shift | 0.005 |
| BB4b | Repair Depressed areas | $m^2$ | Brick<br>coarse sand<br>Sand bedding | piece<br>$m^3$<br>$m^3$ | 16<br>0.026<br>0.061 | Level 3.5/7 | man-day | 0.226 | 60kg vibrating plate copactor | shift | 0.005 |
| **7** | **Sand emulsion seals on concrete bricks with sand filled joints. Mortared edge bricks** | | | | | | | | | | |
| CB1 | Infill cracked or missing mortar in joints on edge bricks | $m^2$ | Cement<br>Coarse sand | kg<br>$m^3$ | 2.84<br>0.01 | Level 3.7/7 | manday | 0.3 | | | |
| CB2 | Remove and replace broken or crushed bricks. | $m^2$ | Concrete brick<br>Coarse sand | piece<br>$m^3$ | 44.5<br>0.0118 | Level 3.5/7 | manday | 0.198 | 60kg vibrating plate copactor | shift | 0.00665 |
| CB3 | Replace missing sand infill to joints. | $m^2$ | Coarse sand | $m^3$ | 0.006754 | Level 3.5/7 | man-day | 0.03 | 60kg vibrating plate copactor | shift | 0.005 |
| CB4 | Repair Depressed areas | $m^2$ | Concrete brick<br>coarse sand<br>Sand bedding | piece<br>$m^3$<br>$m^3$ | 9<br>0.118<br>0.061 | Level 3.5/7 | man-day | 0.226 | 60kg vibrating plate copactor | shift | 0.005 |
| **8** | **Armoured gravel road base** | | | | | | | | | | |
| AG1 | Filling pothole aggregate armouring layer | $m^2$ | Crushed stone graded | $m^3$ | 0.0966 | Level 4.0/7 | manday | 0.125 | Jumping plate compactor | shift | 0.0025 |
| **9** | **Emulsion Stabilised Road base** | | | | | | | | | | |
| ESS | Filling pothole | $m^3$ | Local sand soils<br>Bitumen emulsion | $m^3$<br>kg | 1.22<br>90.3 | Level 4,0/7<br>*(Adjust labour cost from 1.88 to 2.38)* | manday | 2.38 | Jumping plate compactor | shift | 0.033 |
| **10** | **Cement stabilised Road base** | | | | | | | | | | |
| CSS | Filling pothole | $m^3$ | Local sand soils<br>Cement PC30<br>Fine sand<br>Other materials | $m^3$<br>kg<br>$m^3$<br>% | 1.22<br>102<br>0.335<br>1 | Level 4,0/7<br>*(Adjust labour cost from 1.88 to 2.38)* | manday | 2.38 | Jumping plate compactor | shift | 0.033 |

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- Technical Standards – Road Routine Maintenance, 22 TCN 306-03, MoT, 2003.
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- Road Maintenance, Repair and Management - Training Materials, MoT, 1993.

# APPENDICES

## Appendix 1: Illustrations of road conditions and maintenance operations

Emulsion chip seal (As-built)

Cobble stone surface

Clay brick surface

**Cement concrete surface**

**Quarry-run shoulder**

**Slope protection by grass planting**

**Gravel shoulder**

## Appendix 2: Proposed Crushed Stone Limits

| Grading limit BS Standard Sieving | Nominal Aggregate Size (mm) | | |
|---|---|---|---|
| | **14** | **10** | **6** |
| 20 | 100 | - | - |
| 14 | 85 – 100 | 100 | - |
| 10 | 0 – 40 | 85 – 100 | 100 |
| 6.3 | 0 – 7 | 0 – 35 | 85 – 100 |
| 5 | - | 0 – 10 | - |
| 3.35 | - | - | 0 – 35 |
| 2.36 | 0 – 3 | 0 – 3 | 0 – 10 |
| 0.600 | 0 – 2 | 0 – 2 | 0 – 2 |
| 0.075 | - | - | - |

## Appendix 3: Cement Mortar Content Grade 75

| Cement Grade | Material used for $1m^3$ mortar | |
|---|---|---|
| | **Cement (kg)** | **Sand ($m^3$)** |
| 400 | 215 | 0.980 |
| 300 | 255 | 0.953 |
| 200 | 323 | 0.810 |