Technical Note

Soil Slope Routine Maintenance

TN 80

Introduction

The purpose of this Technical Note is to provide a simple and practical guide to undertaking routine maintenance of soil slopes to maintain or improve their stability. Soil slope routine maintenance is an integral part of VicRoads' risk management of roadside geotechnical hazards. This Technical Note includes:

- An overview of common soil slope failure mechanisms on the Victorian road network
- An overview of factors contributing to soil slope failures on the Victorian road network
- A summary of common soil slope routine maintenance practices adopted by VicRoads

Soil Slope Failure Mechanisms

Common soil slope failure mechanisms on the Victorian road network are divided into two categories:

- Failures of soil fill batters, consisting of rotational failures, slumping of soil, embankment fills acting as dams, cavities created by piping, erosion at culvert outlets, erosion of river or creek banks and erosion by wave action
- Failures of soil cut batters, consisting of rotational failures and slumping of soil

Figure 1: Rotational failure.

Figure 2: Slumping of soil.

Figure 3: Embankment fill acting as a dam.

Figure 4: Cavity created by piping.

Figure 5: Erosion at culvert outlet.

Figure 6: Erosion of river bank.

Factors Contributing to Soil Slope Failures

Poor constructions practices, predominantly from prior to the 1970's, are often the cause of rotational failures and slumping of soil. Earthworks were traditionally uncontrolled in this period, resulting in poor quality and/or poorly compacted soil fills with low shear strength. Design soil batter slopes in this period were typically 1.5:1 for fills and 0.75:1 for cuts, resulting in overly steep batters. Contemporary design soil batter slopes are desirably 6:1 and a maximum of 4:1 for fills and desirably 3:1 and a maximum of 2:1 for cuts unless a site specific design is undertaken.

Inadequate or blocked table drains, kerb, pits and culvert inlets can cause rotational failures and slumping of soil on soil fill batters. When blocked, these drains allow water to flow across roads and over soil fill batters. This water seeps into and saturates soil fills, reducing their shear strength.

Figure 7: Blocked table drain.

Blocked culvert inlets are also the cause of embankment fills acting as dams. Embankment fills are always constructed with a culvert to allow the free flow of water. If a culvert inlet becomes blocked, water dams up behind the embankment fill and can overtop and wash away the embankment fill.

Tree falls by trees growing on soil cut batters can cause slumping of soil when tree roots are dragged through the soil. Trees are not planted on soil cut batter slopes steeper than 1.5:1, and any trees growing on soil cut batter slopes steeper than 1.5:1 are self sown. Trees on soil cut batter slopes steeper than 1.5:1 are inherently unstable, and will fall towards the road.

Leaking culverts are typically the cause of cavities created by piping. Piping is subsurface erosion that occurs when water flows through soil fills, dissolves clay particles and carries them away in solution. This creates cavities which over time grow in size and eventually reach the surface.

Figure 8: Leaking culvert.

Culverts outletting on soil fill batters are the cause of erosion at culvert outlets.

Rivers, creeks and oceans are the cause of erosion of river or creek banks and erosion by wave action. Water from rivers, creeks and oceans also seeps into and saturates soil fills, reducing their shear strength.

Rainfall can trigger all soil slope failure mechanisms when it falls directly on or flows over soil slopes. Rainfall seeps into and saturates soil slopes, reducing their shear strength.

Soil Slope Routine Maintenance Practices

Before undertaking soil slope routine maintenance, the soil slope failure mechanism and factors contributing to the soil slope failures must be identified. An appropriate and effective soil slope routine maintenance program can then be developed.

Common soil slope routine maintenance practices adopted by VicRoads are divided into three categories:

- Preventing failures of soil cut batters, consisting of tree removal and constructing new or clearing existing catch drains
- Preventing failures of soil fill batters, consisting of clearing and grading table drains, clearing kerb, clearing pits, clearing culverts and repairing culverts
- Managing failures of soil fill batters, consisting of crack sealing and asphalt regulation and construction of bunds and flumes

Tree Removal

Tree removal consists of removing trees on soil cut batters and on the natural slope above within 1 m of the crest. Tree removal is only undertaken where the soil cut batter slope is 1.5:1 or steeper, and needs to be repeated at 5-10 year intervals to be effective.

Tree removal is undertaken by lopping tress at ground level and poisoning the stump to prevent regrowth.

Tree removal is undertaken over the full height of soil cut batters, and requires the use of elevated work platforms or aerial rope workers for access.

Catch Drains

Catch drains consist of a ditch, mound or combination of both constructed on the natural slope above the crest of a soil cut batter to prevent rainfall flowing over a soil cut batter.

Constructing new catch drains and clearing existing catch drains is typically undertaken by hand because of restricted access.

Clearing catch drains needs to be undertaken at 2-5 year intervals to ensure catch drains remain effective.

Clearing and Grading Table Drains

Clearing table drains prevents water flowing across roads and over soil fill batters and provides a catch area for slumping of soil from soil cut batters.

Grading table drains increases the capacity of table drains and prevents water ponding in table drains and seeping into soil fills.

Clearing Kerb

In areas with high levels of leaf litter, the leaves 'stick' to kerb and clearing kerb is best undertaken using either a skid steer loader pushing a tyre along the invert of the kerb, or a high powered vacuum suction unit.

Clearing Pits

Clearing pits is best undertaken with a street sweeper with a detachable vacuum suction hose and high pressure water jetting to loosen leaf litter.

Clearing Culverts

Clearing culverts is best undertaken using high pressure water jetting.

Repairing Culverts

Options for repairing culverts include:

- Installing end treatments such as wingwalls, endwalls or beaching on geotextile at outlets
- Sealing culverts with a resin lining
- Sleeving culverts with a smaller diameter pipe and grouting the annulus
- Lining culverts with a structural liner

Crack Sealing and Asphalt Regulation

Crack sealing and asphalt regulation are undertaken to seal tension cracking through pavements to prevent water seeping into soil fills.

Asphalt regulation is only undertaken where the pavement has also settled.

Construction of Bunds and Flumes

Bunds consist of a soil or asphalt mound constructed above the crest of a soil fill batter to prevent water flowing over the soil fill batter.

Bunds must discharge to one of the following:

- Via a flume on the soil fill batter to a culvert outlet or the toe of the soil fill batter
- Directly to a culvert outlet

Figure 9: Asphalt bund.

Figure 10: Asphalt bund discharging to flume on soil fill batter.

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Technical Note - Revision Summary

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