

Technical Note

Rock Slope Routine Maintenance

TN 36

Introduction

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

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

Rock Slope Failure Mechanisms

Common rock slope failure mechanisms on the Victorian road network are divided into three categories:

- Rockfalls from rock cut batters, consisting of toppling failures, sliding failures, wedge failures, loose rocks on batter faces and root jacking
- Rockfalls consisting of loose boulders on natural slopes above roads
- Erosion of rock fill batters

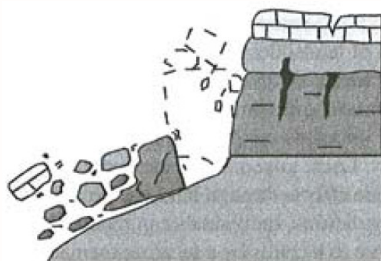


Figure 1: Toppling failure.

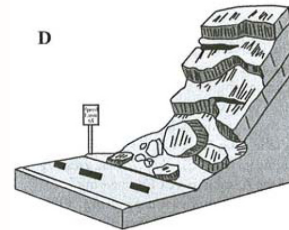


Figure 2: Sliding failure.

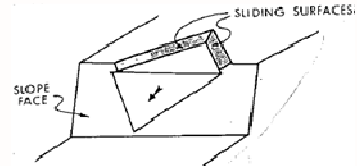


Figure 3: Wedge failure.



Figure 4: Loose rocks on batter face.



Figure 5: Root jacking.



Figure 6: Loose boulders on natural slope.

Factors Contributing to Rock Slope Failures

The type and orientation of defects in the rock mass control the development of toppling failures, sliding failures and wedge failures. Defects are naturally occurring discontinuities within the rock mass and include bedding planes, joints, shear zones, weak seams and faults. An adverse combination of defect orientations and rock cut batter orientation allows the above failure mechanisms to develop on rock cut batters.

Poor constructions practices, predominantly from prior to the 1970's, are often the cause of loose rocks on batter faces. Blasting was more common in this period and traditionally was uncontrolled, resulting in shattered rock cut batter faces with open joints and undercut rock blocks. Contemporary ripping and rock breaking may have a similar effect if uncontrolled. Design rock cut batter slopes in this period were typically 0.75:1, resulting in overly steep batters. Contemporary design rock cut batter slopes are desirably 3:1 and a maximum of 2:1 unless a site specific design is undertaken.

Weathering can cause toppling failures and loose rocks on batter faces. Weathering is a natural effect that turns rock into soil, and occurs faster in defects than the rest of the rock mass. Weathering of joints results in the formation of loose rock blocks between joints, and weathering of weak seams creates undercut rock blocks on rock cut batters.



Figure 7: Weathering and adverse defect orientations.

Trees are the cause of root jacking. The roots of trees growing on rock cut batters grow into defects, expanding and jacking out rock blocks from the rock cut batter face. Trees are not planted on rock cut batters, and any trees growing on rock cut batters are self sown. Trees on rock cut batter slopes steeper than 2:1 are inherently unstable, and will fall towards the road. Tree falls on natural slopes above roads can also trigger rockfalls consisting of loose boulders.

Rainfall is typically the cause of rockfalls consisting of loose boulders on natural slopes above roads. Rainfall reduces the friction between

boulders, and also saturates and reduces the shear strength of any soil underlying boulders, causing this failure type. Rainfall can also trigger all other common rock slope failure mechanisms when it falls directly on rock cut batters, flows over rock cut batters from the natural slope above, or flows through culverts outletting on rock fills.

Culverts outletting on rock fill batters are the cause of erosion of rock fill batters. Erosion occurs where the culvert outlet discharge velocity is greater than 5 m/s and the individual rock blocks are of insufficient mass.

Rock Slope Routine Maintenance Practices

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

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

- Preventing rockfalls from rock cut batters, consisting of scaling, tree removal and constructing new or clearing existing catch drains
- Managing rockfalls from rock cut batters, consisting of clearing rockfalls from table drains, erecting warning signs and constructing temporary rockfall catch fences
- Repairing erosion of rock fills

Scaling

Scaling consists of the removal of loose rocks from rock cut batter faces and loose boulders from natural slopes above roads. Scaling is only undertaken where one or more of the following characteristics are met:

- Rock can be moved by hand or with the use of a pinch bar
- Rock is bounded on all sides by open joints
- Rock is undercut and may fall onto or fall and then roll onto the carriageway or shoulder

Scaling is undertaken using hand held, non-mechanical equipment e.g. pinch bars, crowbars, rakes, shovels, picks etc. Hand held, mechanical equipment such as pneumatic jacks or jackhammers are only used in extenuating circumstances, and excavators and explosives are not used under any circumstances.

Scaling of rock cut batters is undertaken over the full height of rock cut batters, and requires the use

of elevated work platforms or aerial rope workers for access.



Figure 8: Scaling.

Tree Removal

Tree removal consists of removing trees on rock cut batters and on the natural slope above within 1 m of the crest. Tree removal is only undertaken where the rock cut batter slope is 2:1 or steeper, and needs to be repeated at 5-10 year intervals to be effective.

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

Tree removal is undertaken over the full height of rock 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 rock cut batter to prevent rainfall flowing over the rock cut batter.

Construction of 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 Rockfalls from Table Drains

Clearing rockfalls from table drains provides a catch area for further rockfalls from rock cut batters.

Erecting Warning Signs

Rockfall warning signs are installed in accordance with the VicRoads Traffic Engineering Manual Volume 2.2 Part 2.2 page 103-104. Rockfall warning signs are only installed at sites with an assessed risk level of HIGH or VERY HIGH, and consist of a left or right Fallen Rocks symbolic sign and High Risk Area supplementary sign installed on both approaches to the site.



Figure 9: Rockfall warning sign.

Temporary Rockfall Catch Fences

Temporary rockfall catch fences are constructed in emergency situations from concrete or steel longitudinal safety barriers. These barriers are installed in accordance with VicRoads Road Design Note RDN06-04 and in conjunction with other traffic management as required by the *Road Management Act 2004 Worksite Safety – Traffic Management Code of Practice*.



Figure 10: Temporary rockfall catch fence.

Permanent rockfall catch fences require detailed design. Advice should be sought from VicRoads Geotechnical Services to ensure the suitability of permanent rockfall catch fences before they are constructed.

Repairing Erosion of Rock Fills

Repairing erosion of rock fills consists of replacing lost rock fill with greater mass rock fill and/or constructing a flume from the culvert outlet to the toe of the rock fill.

Contact Officer

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Technical Note - Revision Summary
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Date	Clause Number	Description of Revision	Authorised by
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