RESEARCH
Oregon Department of Transportation

Research Notes

RSN 02-06 November 2001

New Guidance on Managing Rockfall

The Problem of Rockfall

Hundreds of millions of dollars are spent annually in the U.S. to construct and maintain rock slopes and reduce rockfall hazards along highways. Rockfall occurs on slopes where rocks may free fall, bounce, roll or slide. Many factors cause rockfall, including discontinuities in the rock, groundwater conditions, climatic change, poor construction practices, trees and weathering. Legal claims and litigation costs resulting from injuries and deaths due to rockfall reach millions of dollars each year.

One of the principal ways that transportation agencies manage rockfall hazards is to provide "catchment areas" (ditches) along the side of the road. The design of catchment areas is critical to their success in reducing rockfall hazards. The current practice is not consistent throughout the United States, because only limited research has been conducted to provide designers with the data they need to make informed design decisions.

Multi-state Partnership

Through a joint effort funded by seven state DOT's and the Federal Highway Administration, the Oregon Department of Transportation (ODOT) has completed an extensive research project to develop design charts for designing rockfall catchment areas. Researchers rolled about 11,250 rocks off five different rock cut slopes of three different heights (40, 60 and 80 feet) into three different catchment areas. The results of the study are contained in a *Rockfall Catchment Area Design Guide*.

Rockfall testing; 40-foot high vertical presplit slope. Circle denotes test rock. Grid lines (middle-right) are for measuring impact and roll out distances.

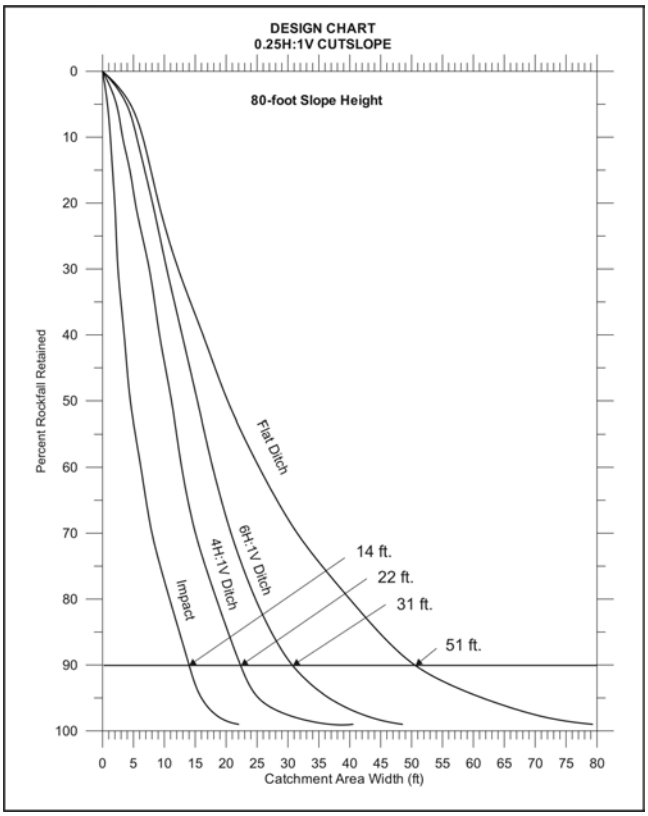
Rockfall Catchment Area Design Guide

The guide contains a set of "practitioner-friendly" design charts, which can be used to design rockfall catchment areas to meet specific rockfall retention requirements. Based on three factors – rock cut slope ratio, vertical rock slope height and catchment area slope – the design charts provide an estimate of the required catchment area widths needed to retain up to 99% of rockfall.

The sample chart (next page) shows the cumulative percentage-retained curves for the 80-foot high, 0.25H:1V slope. The catchment area widths are plotted against the rockfall "cumulative percentages retained." In this example, the horizontal line denotes 90% rockfall retention. The line intersects the impact curve at a catchment area width of 14 feet, which means that 90% of the rocks initially hit the

ground within a 14-foot wide zone adjacent to the toe of the cut slope. The 90th percentile line intersects with the 4H:1V catchment area curve at 22 feet; with the 6H:1V catchment area curve at 31 feet; and with the flat bottom catchment area curve at 51 feet – meaning 90% of all falling rocks had roll out distances less than or equal to these values.

For sites with different height and width configurations, the designer could use other charts to determine the optimum slope and ditch. The same charts can also be used to evaluate the effectiveness of existing catchment areas.



Cumulative percent retained for the 80-foot, 0.25H:1V slope

Additional Features of the Guide

The Design Guide provides guidelines and a step-by-step design procedure using three example problems. In addition, the report includes seven highway project case study examples prepared by geotechnical professionals, that demonstrate the practical application of the design procedure and design charts and the use of site-specific rock rolling to aid in the rockfall mitigation design. The case studies also illustrate other important design considerations, including constructibility and performing benefit-cost comparisons of design alternatives.

With tens of thousands of highway rock slopes in the U.S., some of them decades old, 100% control of rockfall is neither possible nor economically practical. Nonetheless, agencies can have greater confidence in making rockfall control design decisions using the results of this research project.

Request a copy of ***"Rockfall Catchment Area Design Guide"*** *from the ODOT Research Group by phone, e-mail, or in person. Or view the report at* http://www.odot.state.or.us/tddresearch/reports.htm.

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For more information on ODOT's Research Program and Projects, check the website at **http://www.odot.state.or.us/tddresearch/**