DESERT VARNISH
DABNEY STATE PARK

Construction Report

Experimental Features #94-02A

Oregon Department of Transportation

DESERT VARNISH
DABNEY STATE PARK (Region 1)

Construction Report

Experimental Features Project 94-02A

by

Eric W. Brooks, E.I.T
Oregon Department of Transportation
Research Group

for

Oregon Department of Transportation
Research Group
Salem OR 97301-5192

and

Federal Highway Administration
Washington D.C. 20590

April 2000

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
OR-EF-00-11		

4. Title and Subtitle	5. Report Date
Desert Varnish Dabney State Park Construction Report	April 2000
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Eric W. Brooks, E.I.T.	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Oregon Department of Transportation Research Group 200 Hawthorne SE, Suite B-240 Salem, Oregon 97301-5192	11. Contract or Grant No. SRF 306: 94-02A

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Oregon Dept. of Transportation Research Group 200 Hawthorne SE, Suite B-240 Salem, Oregon 97301-5192 and Federal Highway Administration Washington, D.C. 20590	Construction Report
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

In 1997, ODOT mitigated a rock fall hazard on the Historic Columbia River Highway. Loose rock was removed from the overhanging cliff while the sandstone near the base of the cliff was covered with shotcrete to prevent erosion. The shotcrete was then coated with desert varnish to hide the new looking concrete face. The desert varnish is intended to help blend the project into the surrounding environment in this area of high tourist traffic.

The project was completed in the summer of 1999. The desert varnish was applied without any problems. It continues to darken with age so that the shotcrete blends in well with the natural cliff. This report documents the application and initial inspections of the results.

17. Key Words	18. Distribution Statement
Desert Varnish, mitigation, shotcrete, PERMEON™	Available from the ODOT Research Group

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	24	

Technical Report Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

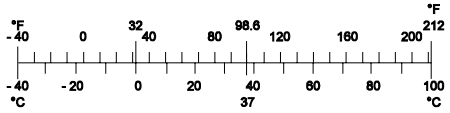
SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8 + 32	Fahrenheit	°F



***** SI is the symbol for the International System of Measurement (4-7-94 jbp)

ACKNOWLEDGEMENTS

The author would like to thank the following Oregon Department of Transportation (ODOT) personnel for their contributions: Mark Beeson, Jim Hamburg, and Jeanette Kloos. Also, the author would like to thank Jill Livingston of Livingston, Inc. for the valuable information she provided at the jobsite.

DISCLAIMER

DESERT VARNISH: DABNEY STATE PARK

TABLE OF CONTENTS

LIST OF FIGURES/PHOTOS

1.0 INTRODUCTION

Desert varnish is the name given to the brown to black coating that forms on stable rock surfaces in certain arid regions of the world. Natural desert varnish can be found in the Sahara Desert, the outback of Australia and the cold dry desert of Antarctica. It also appears in arid high-altitude mountains in Germany as well as on mountains in Colorado and Montana. No one has observed the natural formation of desert varnish, as it is an extremely slow geological process that may take up to 200,000 years to form.

In order to restore the natural appearance of rocky cliffs after construction, an artificial form of desert varnish was synthesized. Initially, the laboratory-created desert varnish was applied to projects in mountainous areas in Arizona, to comply with visual impact laws. The desert varnish was used because reseeding and other reclamation efforts were not feasible.

Concrete support structures can also be colored with desert varnish to blend in with the surroundings. The varnish has been used successfully on retaining walls , dams, irrigation ditches, and cliffs stabilized with shotcrete.

In 1995, the Oregon Department of Transportation (ODOT) used the artificial desert varnish on a slope stabilization project on US 101 near Port Orford. The slope was shaped and reinforced with rock bolts and the bottom portion was covered with shotcrete. Because this scenic area attracts tourists from all over the world, desert varnish was applied to the shotcrete. After 5 years the varnish is still working well. It has given the gray shotcrete a marbled-brown appearance similar to other coastline cliffs in the area *(Hofmann 1995, Brooks 1998).*

A rock fall mitigation project on the Crown Point Highway was completed in 1998. After the loose rocks were removed manually, the base of the cliff was covered with shotcrete. Because the project is in the Columbia River Gorge National Scenic Area and is visited by many tourists, the shotcrete was colored with desert varnish to make it blend with the surroundings.

This report covers the application of desert varnish to the Crown Point Highway project.

1.1 STUDY OBJECTIVE AND METHODOLOGY

The objective of this project is to evaluate the effectiveness of an artificial desert varnish, PERMEON™, in producing a weathered, natural appearance when applied to shotcrete.

Photos will be taken by the principal investigator at one week, one month, six months, one year and two years after application. Photos will also be taken if the wall sustains any damage during this period that requires repairs. Landscape architects from ODOT and the US Forest Service will be asked to review and evaluate the photos after one year and two years.

2.0 PROJECT DESCRIPTION

2.1 PROJECT LOCATION AND ENVIRONMENT

The desert varnish was applied to the shotcrete used on the base of the cliff near Dabney State Park. This park is located east of Portland, Oregon along the Sandy River on the Crown Point Highway at milepost 4.1 (see Figure 2.1). The roadway has been designated as a National Scenic Route and is used by many tourists.

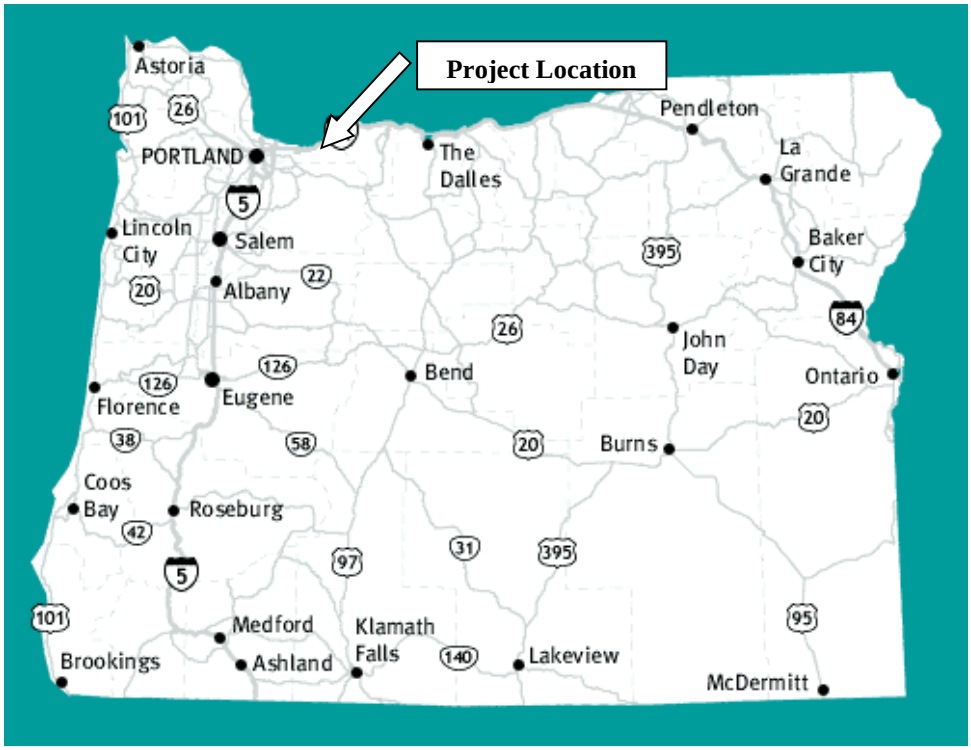


Figure 2.1: Project Vicinity Map

A cross section of the cliff is included in Appendix A. Located in the north Willamette Valley, the annual rainfall is about 45 inches. The winters are mild with only a few freeze-thaw cycles. The mean January temperature is 39 °F, while the mean July temperature is 69 °F.

3.0 CONSTRUCTION

Application of the desert varnish was delayed for several months because of wet weather (desert varnish must be applied to a dry surface). On July 14, 1999, final preparations were made, as there was no rain forecast for the next 24 hours, with only a 20% chance of light showers late on the night of July 15. The contractor prepared the surface by pressure washing the shotcrete, which had been applied the prior year and had some natural buildup of dirt and minerals.

3.1 APPLICATION

The next morning, the desert varnish application went smoothly, with about 250 linear feet completed by 10:00 a.m. The weather was sunny and warm. Traffic was routed one-way in the eastbound lane. The base of the newly cut rock slope was then about 25 feet from the passing cars. Because of the low height to be sprayed and low wind conditions, overspray hitting passing cars was not a problem. Traffic was light and the delay due to the one-way travel was very short.

The PERMEON™ (desert varnish) had been mixed with water in a 5:1 solution, 20 gallons of PERMEON™ to 100 gallons of water. The mix was carried in the back of a pickup truck in a 250-gallon tank. A compressor was used to pressurize the spray to about 200 psi. (see Figure 3.1) The sub-contractor, Livingston, Inc., used a 200-foot hose and an agricultural-type hand-held nozzle to spray the shotcrete-coated cliff.

Figure 3.1: Spraying Equipment to Apply Desert Varnish

Jill Livingston, who was doing the desert varnish application, is an experienced operator. She said that the desert varnish color can range from almost black to a light tan, depending on the

concentration of PERMEON™ and the number of coats to be made. The solution was sprayed on until saturation, when it started to run off the shotcrete. At this saturated value, the desert varnish was intended to match the light brown of the rocks above.

The application went very well, with no complaints about over-spray. Application was completed with materials on hand and no breakdowns occurred.

3.2 MATERIAL DESCRIPTION

When first applied, the PERMEON™ mixture does not have a tint, and the shotcrete returns to its original light gray color as it dries. The coloration process is activated by exposure to ultraviolet light from sunshine. The formulation was selected by spraying test bricks and leaving them for the required exposure time. Because some of the cliff above the shotcrete was darker, additional coats could be required, but because it takes at least a week for the PERMEON™ color to develop, another trip would be required to achieve a darker coloration.

The material safety data sheet for the PERMEON™ indicates that it contains salts of manganese and iron with trace elements chlorine, copper, zinc and phosphoric oxides. (See Appendix B). At the concentrations used, Jill Livingston said the mixture would not kill roadside vegetation or affect fish in nearby streams with running water, but she cautioned that still water, such as small fishponds, should be covered when PERMEON™ is applied nearby.

3.3 POSSIBLE PROBLEMS

Two possible problems were noted: water running over the cliff in a few areas from a local land owners' irrigation effort on the hill above the site (see Figure 3.4), and mineral stains from an unknown source appearing on some of the rocks just above the shotcrete. These two areas should be closely monitored.

Figure 3.2: Dark Streaks on Shotcrete caused by Irrigation Water from Above

Also noted were some cracks in the shotcrete running vertically up the cliff. Some of these cracks extended from weep-hole to weep-hole. These could be potential break-points for the shotcrete. Near the top of the desert varnish, there are areas of overhang which could also be breaking points.

4.0 EVALUATIONS

Jeanette Kloos, ODOT's Historic Columbia River Highway Coordinator, monitored the project as principal investigator. Photographs and inspections were scheduled to be taken at one week, one month, six months, one year and a final inspection after two years. Photographs will be compared and evaluated for the esthetic value of the desert varnish application. A final report will be written soon after the final inspection is completed.

After two weeks, half of the shotcrete with the desert varnish was starting to blend well with the surrounding cliff. The section west of the bridge is well matched, as can be seen by comparing Figures 4.1 and 4.2. East of the bridge, the section is still lighter than the cliff, as shown in Figures 4.3 and 4.4. This section will be watched closely as it should darken with age.

4.1 CONCLUSIONS AND RECOMMENDATIONS

The desert varnish application went smoothly, with traffic easily controlled, all materials on hand, and no breakdowns. Weather conditions were ideal for this application and no complaints were filed about over-spray. Waiting for good weather conditions is a must with this product, in order for it to cure properly without streaking.

An experienced company completed the application. Because the correct application rate is an art learned by experience, it if recommended that future jobs be done by experienced people.

Because of the continued change in the desert varnish coloration, it is recommended that the desert varnish application be monitored for two years.

Figure 4.1: Shotcrete West of Sandy River Bridge before Application of Desert Varnish

Figure 4.2: Shotcrete West of Sandy River Bridge after Application of Desert Varnish

Figure 4.3: Shotcrete East of Sandy River Bridge before Application of Desert Varnish

Figure 4.4: Shotcrete East of Sandy River Bridge after Application of Desert Varnish

5.0 REFERENCES

Brooks, Eric. *Desert Varnish: Rocky Point Viaduct. Final Report.* Oregon Department of Transportation, Research Unit. November 1998.

Hofmann, Kaaren. *Desert Varnish: Rocky Point Viaduct. Construction Report.* Oregon Department of Transportation, Research Unit. January 1996.