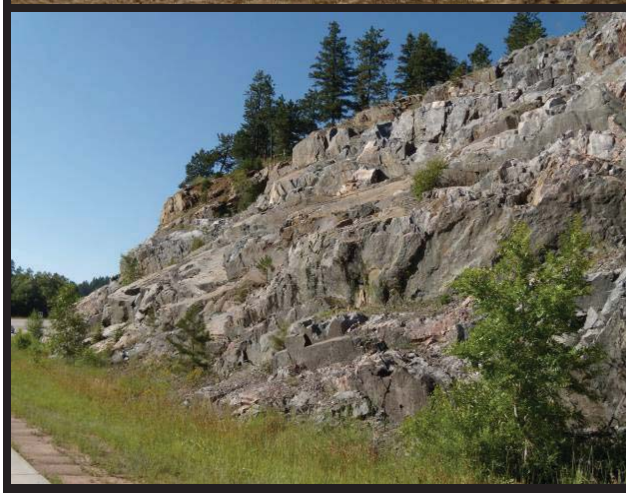
CONTEXT SENSITIVE ROCK SLOPE DESIGN SOLUTIONS

Publication No. FHWA-CFL/TD-11-002 January 2011



U.S. Department of Transportation
Federal Highway Administration

CTIP

Federal Lands Highway
Commitment to Excellence

Central Federal Lands Highway Division
12300 W. Dakota Ave.
Lakewood, CO 80228

FOREWORD

Context sensitive designs in transportation are key to developing facilities that fit within the engineered setting, preserving scenic, aesthetic, historic, and environmental resources while maintaining motorist safety and mobility. Many Federal Land Management Agency partners of the Federal Highway Administration (FHWA) Federal Lands Highway Division (FLHD) manage roads in complex geologic settings, with steep mountainous terrain and various environmental concerns. Projects constructed in these areas often require rock excavation, slope stabilization, and rockfall mitigation to achieve the desired roadway template. Projects constructed in these areas often require rock excavation, slope stabilization, and rockfall mitigation to achieve the desired roadway template. In many cases, traditional methods of excavation are not suitable for these projects. For example, in national parks and forests, presplitting during rock blasting has been prohibited for aesthetic reasons. Even along state-owned roads, these blasting methods are becoming less common. In areas where rockfall is a danger, devices such as rock bolts, rock fences, catchment ditches, or wire mesh nets must be installed.

Recently, new technologies have emerged for use on transportation projects that can provide natural-looking cuts while maintaining the stability of the slope. But while many stabilization and rockfall mitigation methods are available, context sensitive solutions are not widely used within the FLHD regions. Thus, guidelines are needed to help engineers design various context sensitive stabilization and mitigation systems that meet all safety, environmental, and aesthetic requirements.

F. David Zanetell, P.E., Director of Project Delivery
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Technical Report Documentation Page

<table>
<tr><td>1. Report No.
FHWA-CFL/TD-11-002</td><td>2. Government Accession No.</td><td colspan="2">3. Recipient's Catalog No.</td></tr>
<tr><td colspan="2" rowspan="2">4. Title and Subtitle

Context Sensitive Rock Slope Design Solutions</td><td colspan="2">5. Report Date
January 2011</td></tr>
<tr><td colspan="2">6. Performing Organization Code
J2009-05</td></tr>
<tr><td colspan="2">7. Author(s)
Richard D. Andrew, Ryan Bartingale and Howard Hume</td><td colspan="2">8. Performing Organization Report No.</td></tr>
<tr><td colspan="2" rowspan="2">9. Performing Organization Name and Address
Yeh and Associates, Inc.
5700 E. Evans Ave.
Denver, CO 80222</td><td colspan="2">10. Work Unit No. (TRAIS)</td></tr>
<tr><td colspan="2">11. Contract or Grant No.
DTFH68-07-D-00001</td></tr>
<tr><td colspan="2" rowspan="2">12. Sponsoring Agency Name and Address
Federal Highway Administration
Central Federal Lands Highway Division
12300 W. Dakota Ave., Suite 210B
Lakewood, CO 80228</td><td colspan="2">13. Type of Report and Period Covered
Final Report
June 2008 – December 2010</td></tr>
<tr><td colspan="2">14. Sponsoring Agency Code
HFTS-16.4</td></tr>
<tr><td colspan="4">15. Supplementary Notes
COTR: Khamis Haramy, FHWA-CFLHD. Advisory Panel Members: Khamis Haramy, Mathew DeMarco, and Roger Surdahl, FHWA-CFLHD; Khalid Mohamed, FHWA-EFLHD; Rich Barrows, FHWA-WFLHD; Scott Anderson and Barry Siel, FHWA-RC; Matt Greer, FHWA-CO; and Ty Ortiz, CDOT. This project was funded under the FHWA Federal Lands Highway Coordinated Technology Implementation Program (CTIP).</td></tr>
<tr><td colspan="4">16. Abstract

The Federal Highway Administration (FHWA) Federal Lands Highway Division (FLHD) evaluated the application of context sensitive solutions (CSS) for rock slope design. The application of context sensitive design in transportation is a method of developing facilities that fit within the engineered setting and preserve scenic, aesthetic, historic, and environmental resources while maintaining safety and mobility.

Proper development of context sensitive solutions starts before the scoping stage and incorporates a number of factors, including community concerns, the effects of roadway development on the physical character of the surrounding area, and a visual prioritization of design considerations. Before starting construction, the contractor and land management agency should agree on a defined standard of performance and communication protocols to ensure that all project goals are attained.

The aesthetics of common rock slope construction and mitigation practices can be enhanced with some modifications. Advantages, limitations, design guidelines, aesthetic value, construction materials, case examples, relative costs, and maintenance procedures are included for each method. Discussions are intended to guide the reader in CSS rock slope development.</td></tr>
<tr><td colspan="2">17. Key Words
CONTEXT SENSITIVE SOLUTION, CSS, ROCK SLOPES, ROCK EXCAVATION, AESTHETIC ROCK SLOPE, SLOPE STABILIZATION, ROCKFALL PROTECTION.</td><td colspan="2">18. Distribution Statement
No restriction. This document is available to the public from the sponsoring agency at the website http://www.cflhd.gov.</td></tr>
<tr><td>19. Security Classif. (of this report)
Unclassified</td><td>20. Security Classif. (of this page)
Unclassified</td><td>21. No. of Pages
122</td><td>22. Price</td></tr>
</table>

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	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	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 (or metric tons)	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	Lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

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	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric tons")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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LIST OF SYMBOLS AND ABBREVIATIONS

~	Approximately equal to
AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials/ASTM International
AWG	American Wire Gage
BS	British Standard
CALTRANS	California Department of Transportation
CDOT	Colorado Department of Transportation
CFLHD	Central Federal Lands Highway Division
CSS	Context Sensitive Solutions
DOT	Department of Transportation
EFLHD	Eastern Federal Lands Highway Division
FHWA	Federal Highway Administration
FLH	Federal Lands Highway
FLHD	Federal Lands Highway Division
FS	Factor of Safety
ft	Foot (feet)
ft^2	Square foot (feet)
ft-tons	Foot-Tons
in	Inch(es)
kJ	KiloJoules
kPa	Kilopascal
m	Meter(s)
m^2	Square meter(s)
MPa	Megapascal
MSE	Mechanically Stabilized Earth
PTI	Post-Tensioning Institute
PVC	Polyvinyl Chloride
U.S.	United States
WFLHD	Western Federal Lands Highway Division

ACKNOWLEDGMENTS

We are grateful for the contributions and cooperation of the Central Federal Lands Highway Division (CFLHD) advisory panel (Khamis Haramy, Mathew DeMarco, Roger Surdahl, Khalid Mohamed, Rich Barrows, Scott Anderson, Barry Siel, Matt Greer, and Ty Ortiz). Specifically, Khamis Haramy's efforts and contributions in the role of CFLHD's Contracting Officer's Technical Representative (COTR) are greatly appreciated. Finally, we extend our thanks to Martha Connors who performed the detailed editing of this document.