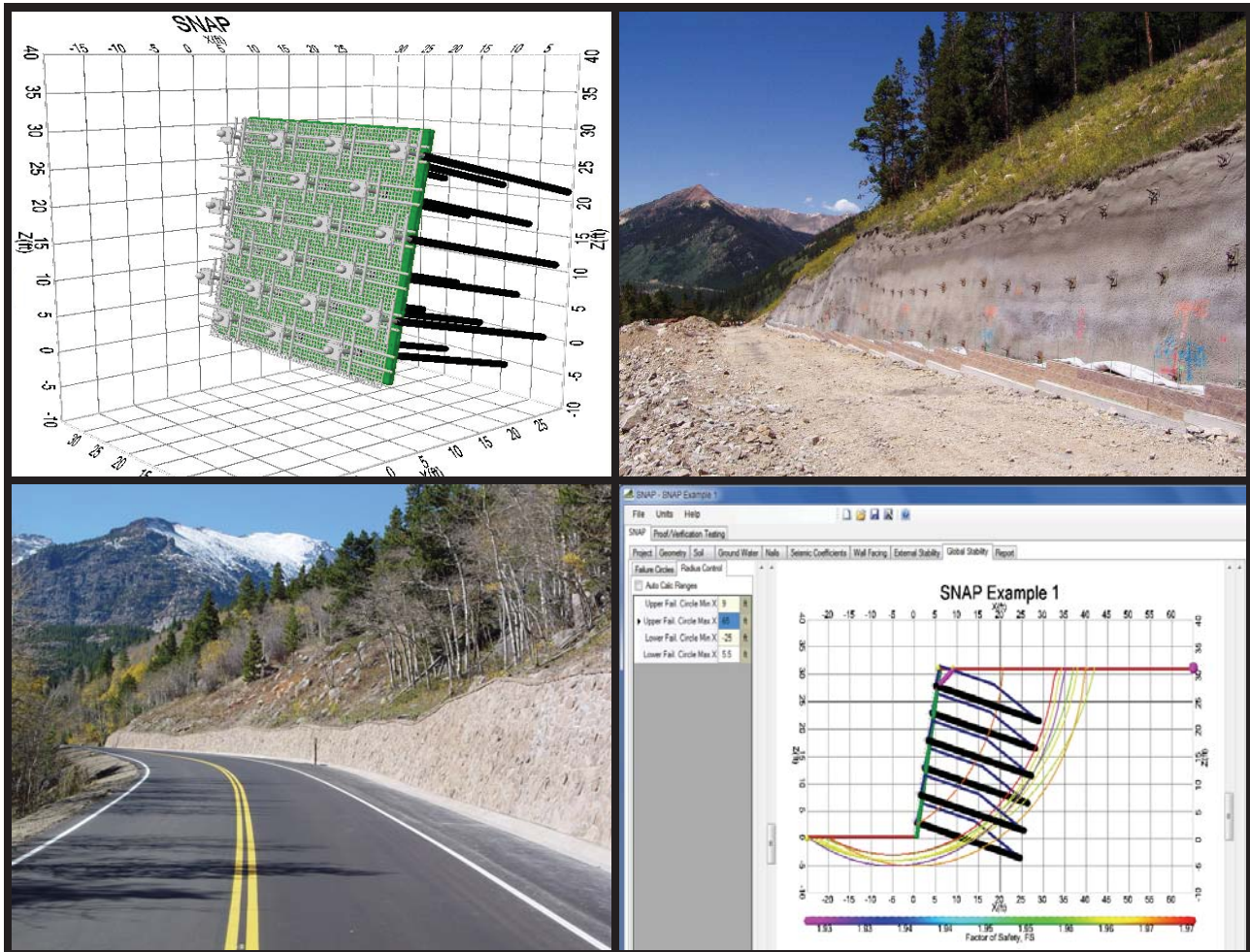


SNAP (SOIL NAIL ANALYSIS PROGRAM) User's Manual

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U.S. Department
of Transportation
**Federal Highway
Administration**

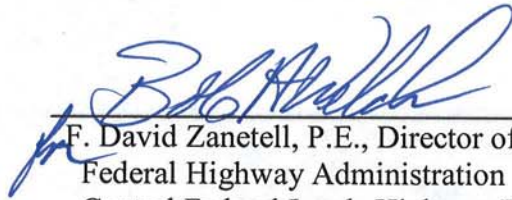


Central Federal Lands Highway Division
12300 West Dakota Avenue
Lakewood, CO 80228

FOREWORD

The Office of Federal Lands Highway (FLH) of the Federal Highway Administration (FHWA) promotes development and deployment of applied research and technology applicable to solving transportation related issues on Federal Lands. The FLH provides technology delivery, innovative solutions, recommended best practices, related information, and knowledge sharing to Federal agencies, Tribal governments, and other offices within the FHWA.

The current design process for soil nail earth retention systems is inefficient because multiple tools are needed for facing, internal, external, and global design. These tools do not communicate with one another, and are often used by different staff members. The main objective of this work was to develop a single State-of-Practice computer program for designing the entire soil nail earth retaining structure, including nail elements, facing elements, global stability, and evaluation of internal and external wall stability based on the current AASHTO design standards. By combining all these assessment tools into one package, we take another step towards assuring high quality and efficient designs and accelerating project delivery.



F. David Zanetell, P.E., Director of Project Delivery
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16. Abstract <p>Soil nail walls are internally stabilized earth-retaining structures. Soil nail walls use a top-down construction with in situ reinforcement to support temporary or permanent excavations. In certain conditions, soil nailing is a viable alternative to other ground anchor systems, considering technical feasibility, cost, and construction duration.</p> <p>Although the use of soil nail walls for highway applications has increased dramatically in the past decade, computer programs for the design of soil nail walls are not up to date. The main objective of this work is to develop a state-of-the-practice computer program (<u>Soil Nail Analysis Program</u>) for designing all components of soil nail retaining structures, including nail and facing elements. The program will evaluate the internal and external wall stability (including limit-equilibrium global slope stability) based on the current standards in the ASD method. In addition, the program may be used to evaluate verification and proof field test results. All design and evaluation procedures are according to the FHWA guidelines presented in 1) The Manual for Design and Construction of Soil Nail Walls, Report No. FHWA-SA-96-069R, and 2) Geotechnical Engineering Circular No. 7 - Soil Nail Walls, Report No. FHWA-IF-03-017.</p> <p>This user's manual discusses the theoretical basis for the computer program, gives a comparison of available soil nail wall design guidelines, discusses program execution including inputs and outputs, and includes two worked examples to demonstrate use of the program.</p>			
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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 yard	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 ton")	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 ton")	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

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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LIST OF SYMBOLS AND ABBREVIATIONS

A	Peak ground acceleration due to seismic loading
AASHTO	American Association of State Highway and Transportation Officials
ASD	Allowable Stress Design
B	Wall base length
CalTrans	California Department of Transportation
CFLHD	Central Federal Lands Highway Division
CIP	Cast-in-place
COTR	Contracting Officer's Technical Representative
DOS	Disk Operating System
FHWA	Federal Highway Administration
FLH	Federal Lands Highway
ft	foot (feet)
ft ²	square feet
ft ³	cubic feet
FS	Factor of Safety
in	inches
in ²	square inches
K _a	Active earth pressure coefficient
k _h	Horizontal seismic coefficient
kip	kilo pound (1000 pounds)
kN	kilo Newton(s), SI unit of force
kPa	kilo Pascal
k _v	Vertical seismic coefficient
lb	pounds of mass
lbf	pounds of force
L _{BV}	Maximum bond length to avoid overstressing the nail during a verification or proof field test
LRFD	Load Resistance Factor Design

m	meter
m ²	square meters
m ³	cubic meters
MSE	Mechanically Stabilized Earth
N _c	Bearing capacity factor
N _q	Bearing capacity factor
N _γ	Bearing capacity factor
NCHRP	National Cooperative Highway Research Program
P _{AE}	Dynamic horizontal thrust force due to seismic loading
psi	pounds per square inch
Q	Allowable pullout resistance between grout and soil, e.g., pounds/foot (or kN/m)
Q _u	Ultimate pullout resistance per unit of nail length (grout-ground bond)
SI units	International System of units (e.g. m, N, kPa, etc.)
SNAP	Soil Nail Analysis Program
T _F	Allowable nail head load, e.g., kips (or kN)
T _N	Allowable nail tendon load, e.g., kips (or kN)
T _{FN}	Controlling nominal nail head load
US units	United States customary units (e.g., ft, lbf, psi, etc.)
φ	Internal friction angle of a soil

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