THE ESSENCE OF NATURAL ROCK

REDI-ROCK

FREESTANDING WALL SERIES

Redi-Rock International
05481 US 31 South
Charlevoix, MI 49720
866-222-8400
info@redi-rock.com
www.redi-rock.com

Check with your local authorized
Redi-Rock® Manufacturer for Product Availability

FREESTANDING SERIES BLOCKS

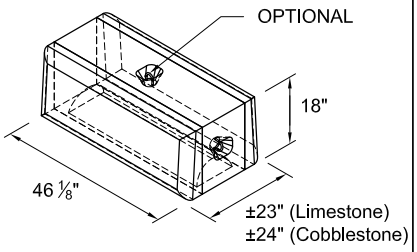
(FINISHED ON TWO SIDES)

Straight Top

(Smooth or Textured)

Full Block (46 1/8")
- Volume = 10.46 cft
- Weight = ±1496 lbs

Half Block (23 1/16")
- Volume = 5.22 cft
- Weight = ±747 lbs

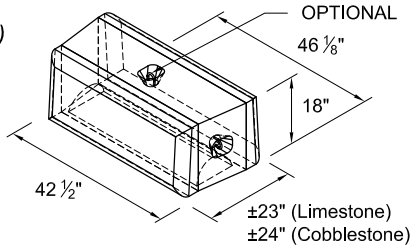


Curved Top

(Smooth or Textured)

Volume = 10.03 cft

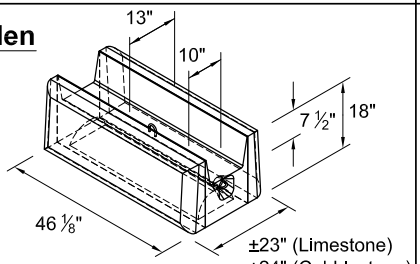
Weight = ±1434 lbs



Straight Top Garden

Full Block (46 1/8")
- Volume = 7.98 cft
- Weight = ±1141 lbs

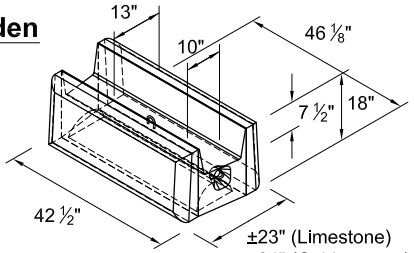
Half Block (23 1/16")
- Volume = 3.97 cft
- Weight = ±567 lbs



Curved Top Garden

Volume = 7.65 cft

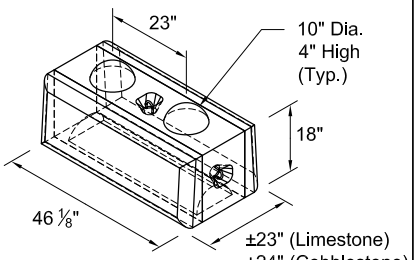
Weight = ±1093 lbs



Straight Middle

Full Block (46 1/8")
- Volume = 10.68 cft
- Weight = ±1527 lbs

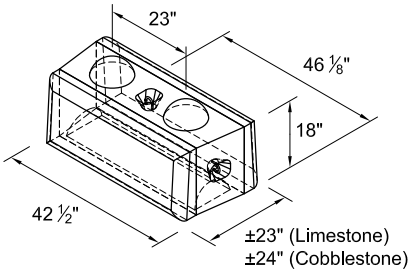
Half Block (23 1/16")
- Volume = 5.33 cft
- Weight = ±762 lbs



Curved Middle

Volume = 10.24 cft

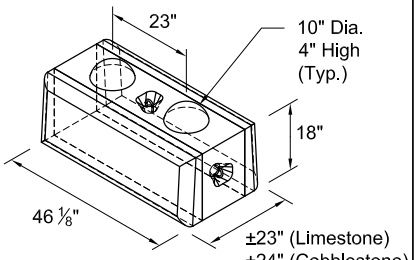
Weight = ±1465 lbs



Straight Bottom

Full Block (46 1/8")
- Volume = 11.53 cft
- Weight = ±1649 lbs

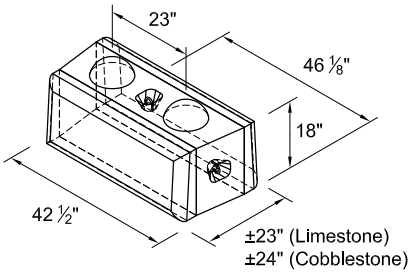
Half Block (23 1/16")
- Volume = 5.74 cft
- Weight = ±821 lbs



Curved Bottom

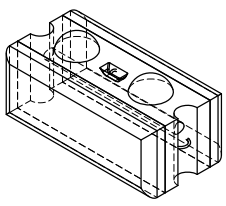
Volume = 11.10 cft

Weight = ±1588 lbs



Force Protection

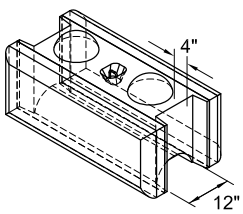
Straight blocks can be manufactured with a 3" horizontal tube for post-tensioned cable installation.
Straight and curved blocks can be manufactured with 6" vertical tubes for mechanical tie-down bolt installation.



(Straight Full Bottom Block Shown)

Variable Radius Walls

Straight block styles can be manufactured with the end block insert to allow the blocks to be used in a variable radius wall.



(Straight Full Middle Block Shown)

NOTES:

Architectural faces on the blocks have varying texture.

Volumes are based on the blocks as shown.

Actual weights and volumes may vary.

Weight shown is based on 143 pcf concrete.

DRAWN BY: J. JOHNSON	03/18/10	Redi-Rock® International, LLC	
CHECKED BY:			
APPROVED BY:		DRAWING FILE: FS Series Blocks 031810.dwg	REVISION: --
ISSUE DATE:		SCALE: NO SCALE	SHEET NO.: 1 OF 1

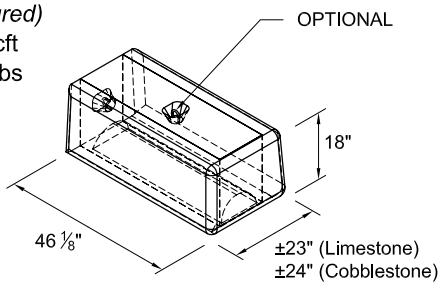
FREESTANDING

FREESTANDING SERIES CORNERS

(FINISHED ON THREE SIDES)

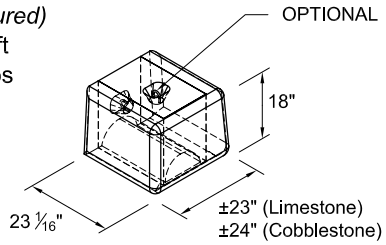
Top Corner

(Smooth or Textured)
Volume = 10.44 cft
Weight = ±1493 lbs



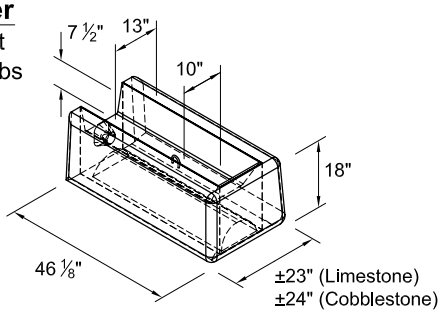
Half Top Corner

(Smooth or Textured)
Volume = 5.18 cft
Weight = ±741 lbs



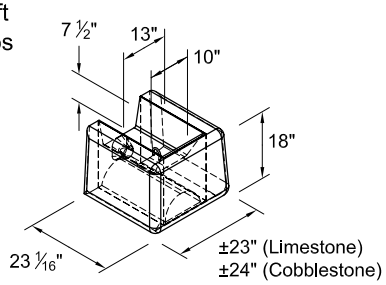
Garden Corner

Volume = 8.26 cft
Weight = ±1182 lbs



Half Garden Corner

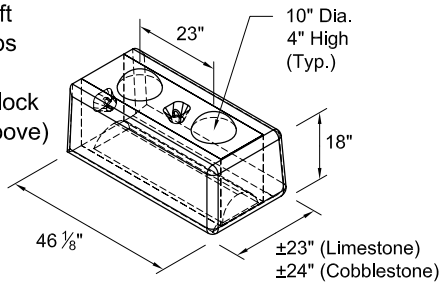
Volume = 4.25 cft
Weight = ±607 lbs



Middle Corner

Volume = 10.73 cft
Weight = ±1534 lbs

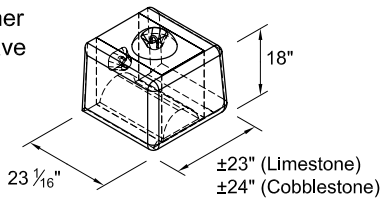
(Bottom Corner Block does not have groove)



Half Middle Corner

Volume = 5.28 cft
Weight = ±755 lbs

(Half Bottom Corner Block does not have groove)



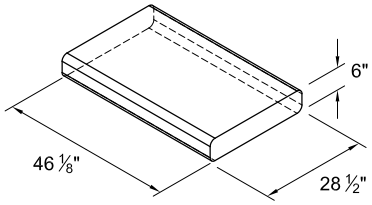
NOTES:

Architectural faces on the blocks have varying texture.
Volumes are based on the blocks as shown.
Actual weights and volumes may vary.
Weight shown is based on 143 pcf concrete.

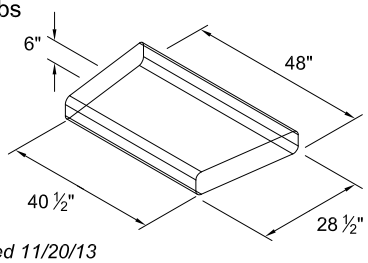
DRAWN BY: J. JOHNSON	10/05/09	Redi-Rock® International, LLC	
CHECKED BY:			
APPROVED BY:		DRAWING FILE: FS Series Corners 100509.dwg	REVISION: --
ISSUE DATE:		SCALE: NO SCALE	SHEET NO.: 1 OF 1

6" CAP BLOCKS

Two-Sided Cap
Volume = 4.50 cft
Weight = ±644 lbs

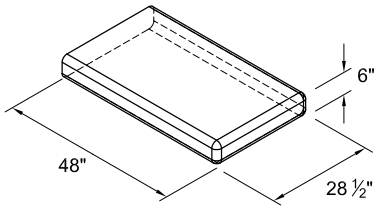


Two-Sided Curve Cap
Volume = 4.25 cft
Weight = ±608 lbs

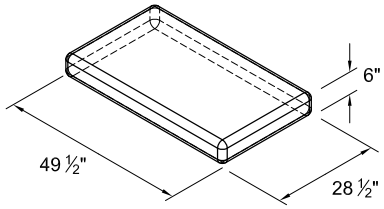


Dimensions Updated 11/20/13

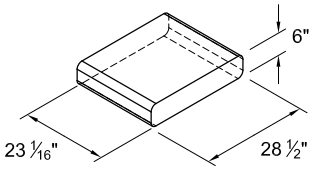
Three-Sided Cap
Volume = 4.68 cft
Weight = ±669 lbs



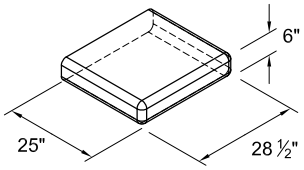
Four-Sided Cap
Volume = 4.81 cft
Weight = ±688 lbs



Two-Sided Half
Volume = 2.25 cft
Weight = ±322 lbs



Three-Sided Half
Volume = 2.43 cft
Weight = ±347 lbs

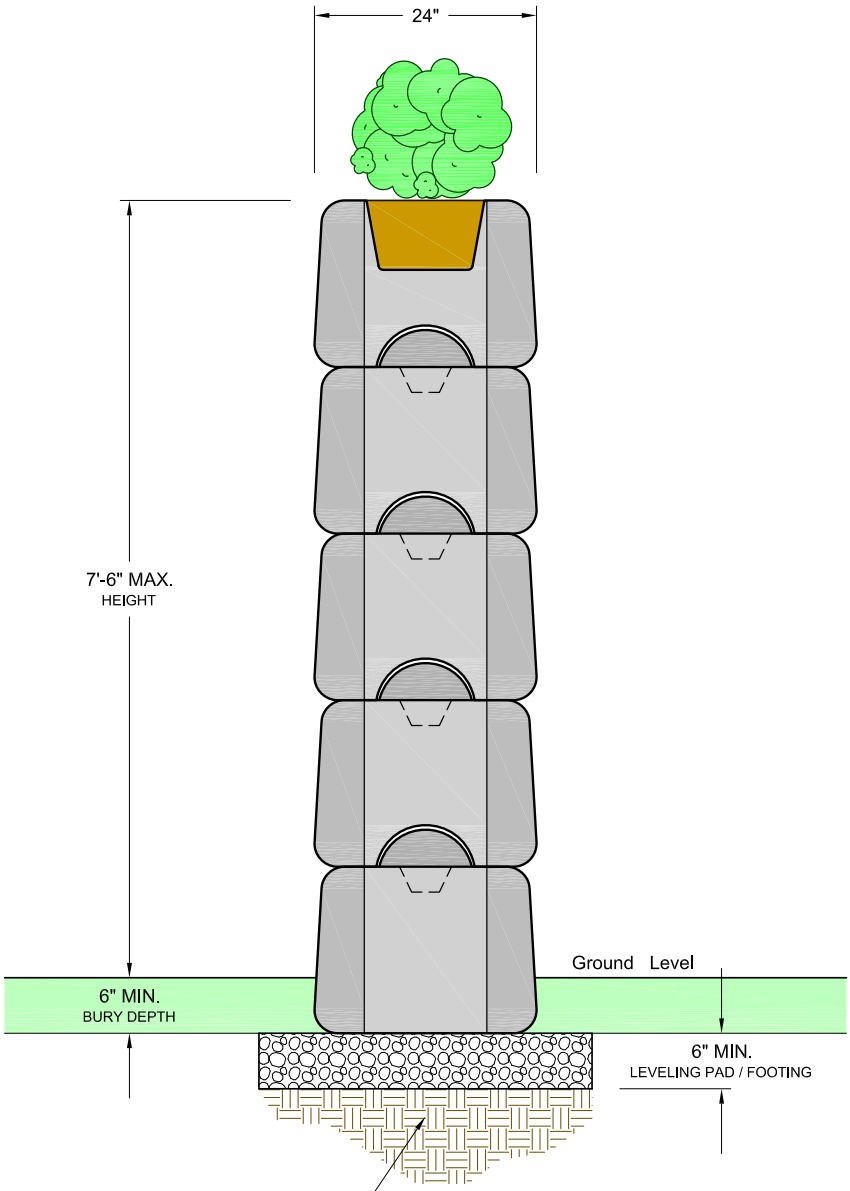


NOTES:
Volume based on blocks as shown.
Actual weights and volumes may vary.
Weight shown is based on 143 pcf concrete.

DRAWN BY: J. JOHNSON	11/20/13	Redi-Rock® International, LLC	
CHECKED BY			
APPROVED BY		DRAWING FILE: FS Series Cap Blocks 112013.dwg	REVISION: --
ISSUE DATE		SCALE: NO SCALE	SHEET NO.: 1 OF 1

FREESTANDING

Perimeter Freestanding Wall



Footing bearing material shall be granular and compacted to 95% of standard proctor, 90% of the modified proctor or in-situ compacted and tested to ensure adequate bearing capacity.

DRAWN BY: J. JOHNSON	01/04/10	Redi-Rock® International, LLC	
CHECKED BY:			
APPROVED BY:		DRAWING FILE: FS GP 750 010410.dwg	REVISION: —
ISSUE DATE:		SCALE: NO SCALE	SHEET NO.: 1 OF 1

THE ESSENCE OF NATURAL ROCK

REDI-ROCK

FORCE PROTECTION SERIES

Note: Computer simulations can be found on the following pages. Full-scale crash tests have not been performed, thus the system is not rated to any testing standard.

Redi-Rock International
05481 US 31 South
Charlevoix, MI 49720
866-222-8400
info@redi-rock.com
www.redi-rock.com

Check with your local authorized
Redi-Rock Manufacturer for Product Availability

POURED-IN-PLACE CONCRETE BEAM SIMULATION: 90° IMPACT (15 mph)

Full-scale crash tests have not been performed, thus the system is not rated to any testing standard.

Vehicle Used: 8,000 lb vehicle traveling at 15 mph
Impact Angle between wall & vehicle: 90 degrees
Wall Used in Model:

- Wall consisted of three rows of retaining wall blocks under two rows of free-standing blocks and one row of cap blocks. The lowest row of retaining wall blocks was buried six inches. The total wall length was 49'-10" with a height of 94".
- The top-most row of free-standing blocks consisted of pre-cast garden blocks with a groove running the full length of the block. After construction of the wall, a poured-in-place concrete beam reinforced with two strands of rebar was positioned inside the groove.

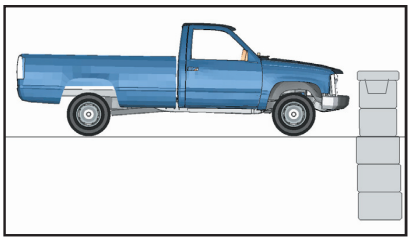
Results:

- The maximum wall deformation was 6.1 inches.
- Considering the height of the wall and a displacement of 6.1 inches, the maximum tilt of the wall reached 3.7 degrees before rebounding somewhat.
- The caps on the top of the wall remained attached to the blocks below.
- The only mechanical factors available for absorbing the initial kinetic energy were the concrete blocks, the deformable truck, and the frictional losses due to contact. Comparitively speaking, the energies absorbed for the wall, truck, and friction were roughly 27%, 59%, and 11% respectively, totaling 97%, the remaining 3% attributed to miscellaneous.

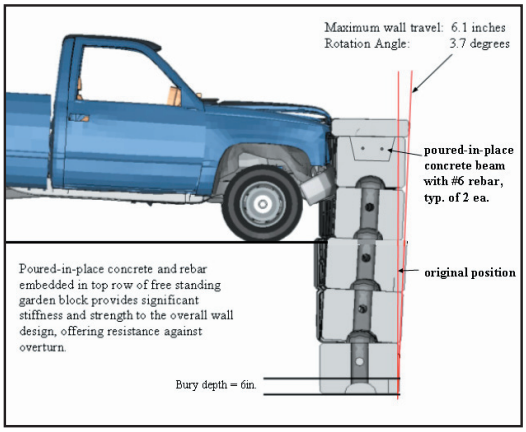
Conclusion:

"Any head-on collision with a vehicle weighing 8,000lbs or less, and traveling 15mph or less, should not cause the wall to fall over, or the caps to act like projectiles...Comparison between the force-protection design and the poured-in-place beam design results indicates an overall stiffer design in the latter... As a broad assessment, it is reasonable to conclude that the poured-in-place concrete beam design is a more appropriate choice for low speed impacts because stopping the impact will be governed by wall "stiffness".

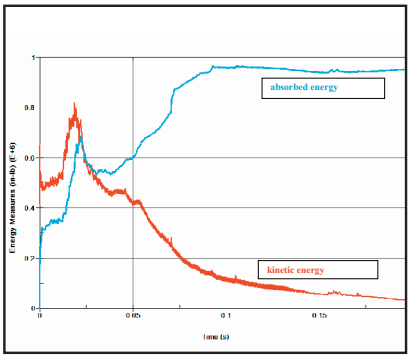
Prior to Impact



Maximum Deformation



Energy Transformation & Balance Graph



For computer simulations, visit www.redi-rock.com

FREESTANDING

25° GUARDRAIL SIMULATION (31 mph)

Full-scale crash tests have not been performed, thus the system is not rated to any testing standard.

Simulation Agency: MDG Solutions, Inc. Pittsburg, PA 412-492-8220

Vehicle Used: 4,400 lb vehicle traveling at 31 mph
Impact Angle between wall & vehicle: 25 degrees
Wall Used in Model:

- Two courses high by ten courses long retaining wall, with each block weighing 2,500 lb.
- Above retaining courses, two courses high by ten courses long free-standing wall, with each block weighing 1,300 lb.
- Above free-standing courses, finishing cap weighing 450 lb., adhesively bonded to block it sat upon.
- The mechanical links embedded inside the wall were ¾" heavy-duty J-bolts placed between the two courses of free-standing wall, and one row of these J-bolts connecting the bottom course of free-standing blocks with the top course of retaining wall blocks. Only gravity and friction joined the two rows of retaining wall blocks.

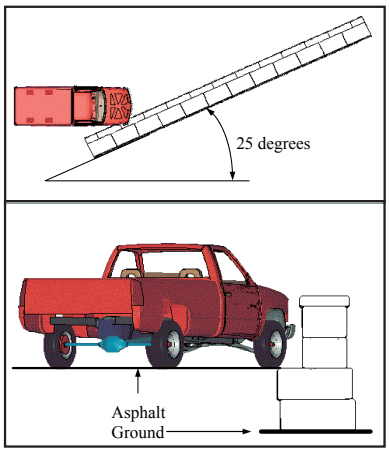
Results:

- Vehicle trajectory stayed on course through the first 0.122 seconds.
- After 0.122 seconds the trajectory and acceleration of the vehicle CG showed signs of changing direction and slowing, respectively. The movement of the undercarriage indicated a tendency for the truck to swerve in away from the wall. The truck also tended to "bend" about the cabin.
- Wheel snagging was evident. The results of this study are strong indicators that allow us to draw the conclusion that vehicles impacting a Redi-Rock wall system will experience wheel snag almost always due to the inflexibility of the wall and the large interface friction that catches and holds the rubber tire against the concrete block.
- The caps that positioned on the top of the wall remained attached to the blocks below.
- This computer model included 3/4" J-bolts. Four of the twenty-two J-bolts developed the greatest amount of stress and deformation. According to the manufacturer, the J-bolt maximum allowable tensile stress is 44,000psi. Failure is at approximately 60,000psi. During the test, the maximum amount of tensile stress developed in the J-bolt shafts was 52,000psi.
- The model also included ½" diameter #4 rebar hooks that the J-Bolts attached to. The yield stress of #4 rebar is 60,000psi, the ultimate stress is roughly 90,000psi. During the test, the maximum tensile stress for the exposed rebar hooks was roughly 80,000psi.

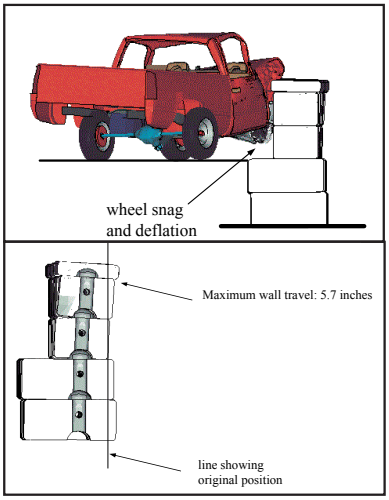
Conclusion:

"The 25 Degree angle crash analysis results appear 'successful' when measured against the criterion of the wall must not topple over during the impact event."

Prior to Impact



Maximum Deflection--0.17 sec.



Results Summary:

ENERGY ABSORBING COMPONENTS	PERCENTAGE OF ENERGY ABSORBED (%)
Concrete blocks	6.4
Cables	n/a
Vertical connections	0.3
Frictional loss	25.0
Ground anchors	n/a
Vehicle	67.0
Remaining kinetic energy	0.0
Miscellaneous	1.3
TOTALS	***100.0%***

For computer simulations, visit www.redi-rock.com

J-Bolt / J-Clip Connection

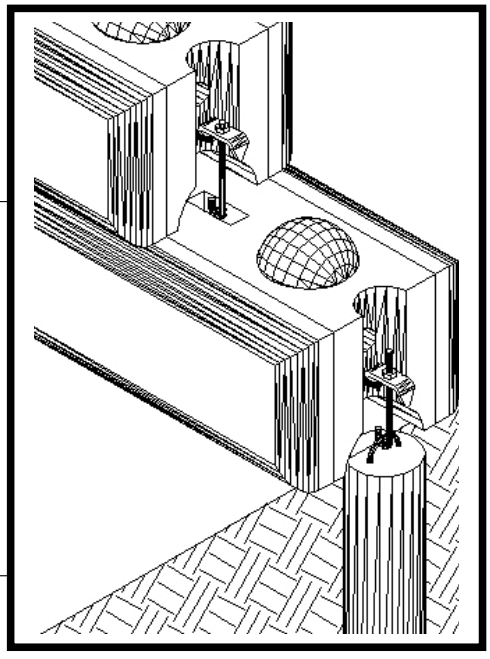
Plain Steel	Size	Dia. (in.)	Cross Sectional area ($in.^2$)	Allowable Tensile Stress F_t (Ksi)	Allowable Tensil Load (lb)
ASTM A325 Heavy Duty Bolt/ Clip	$^3/_4$"	0.750	0.4418	44.0	19,400

Re-Bar Hooks Cast Integral w/Redi-Rock Block

	Bar Size	Dia. (in.)	Cross Sectional area ($in.^2$)	Weight ($^{lb}/_{lft}$)	Yield Strength f_y ($^{lb}/_{sq\ in}$)	Nominal Shear Strength (lb)
Standard Duty	# 4	0.500	0.20	0.668	60,000	9,600
Heavy Duty	# 5	0.625	0.31	1.043	60,000	14,880

Reinforcing steel per ACI 318 for development length and minimum bend diameters.

Ignoring any shear plane contribution from concrete, $V_n = 0.8\ A_{vf} fy$



Ground Anchors

Type used to be determined by project and anchor systems locally available.
Holding capacity will vary depending upon soil properties. *
Pre-construction field testing is highly recommended.
Cost each will depend on quantity and site/soil conditions.

Possible Options:

- Install 12" Diameter x 3' deep concrete ground anchor with appropriate standard or heavy duty reinforcing steel.

90° GUARDRAIL SIMULATION (15 mph)

Full-scale crash tests have not been performed, thus the system is not rated to any testing standard.

Simulation Agency: MDG Solutions, Inc. Pittsburg, PA 412-492-8220

Vehicle Used: 4,400 lb vehicle traveling at 15 mph
Impact Angle between wall & vehicle: 90 degrees
Wall Used in Model:

- Two courses high by ten courses long retaining wall, with each block weighing 2,500 lb.
- Above retaining courses, two courses high by ten courses long free-standing wall, with each block weighing 1,300 lb.
- Above free-standing courses, finishing cap weighing 450 lb., adhesively bonded to block it sits upon.
- The mechanical links embedded inside the wall were ¾" heavy-duty J-bolts placed between the two courses of free-standing wall, and one row of these J-bolts connecting the bottom course of free-standing blocks with the top course of retaining wall blocks. Only gravity and friction joined the two rows of retaining wall blocks.

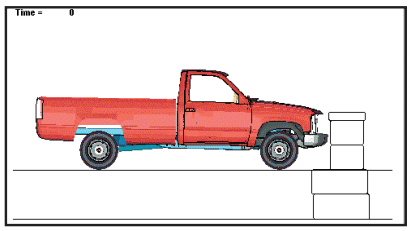
Results:

- The wall showed little deformation remaining after vehicle rebound, however its maximum deformation was 6.6 inches.
- The top three courses acted as an integral unit and pivoted on the bottom course, resulting in a total tilt of 4.7 degrees. The two retaining wall courses demonstrated the "knob and groove" concept keeping the courses together for as long as possible. The weight of the wall and the high level of friction generated between the retaining wall courses pulled upward on the bottom row a small amount.
- The caps positioned on the top of the wall remained attached to the blocks below.
- The computer model included 3/4" J-bolts. Three out of the twenty two J-bolts used recieved the most stress during this analysis. According to the manufacturer, the J-bolt maximum allowable tensile stress is 44,000psi. Failure is at approximately 60,000psi. During the test, the maximum tensile stress for the exposed rebar hooks was 72,152psi. The vehicle began its rebound and the wall returned towards its original position before the J-bolts lost connection.

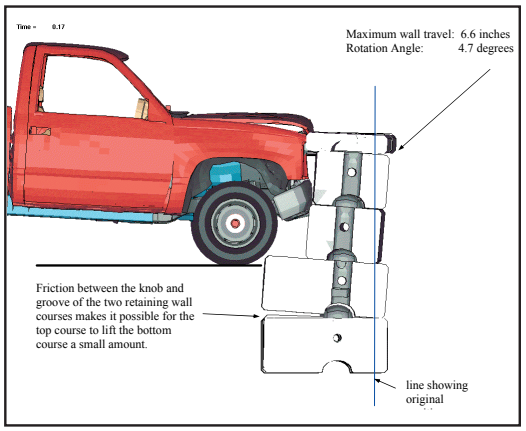
Conclusion:

"Any head-on collision with a vehicle weighing 4,400lbs or less, and traveling 15mph or less, should not cause the wall to fall over, or the caps to act like projectiles. There will definitely be notable shifting of the wall blocks, and possible over-stressing of the J-bolts brackets causing them to loose contact with the rebar, but again, the wall should not fall over or the caps dislodge."

Prior to Impact



Maximum Deformation--0.17 sec.



Results Summary

ENERGY ABSORBING COMPONENTS	PERCENTAGE OF ENERGY ABSORBED (%)
Concrete blocks	21.0
Cables	N/a
Vertical connections	1.6
Frictional loss	3.8
Ground anchors	N/a
Vehicle	71.4
Remaining kinetic energy	N/a
Miscellaneous	2.2
TOTALS	***100.0%***

For computer simulations, visit www.redi-rock.com

90° GUARDRAIL SIMULATION (30 mph)

Full-scale crash tests have not been performed, thus the system is not rated to any testing standard.

Simulation Agency: MDG Solutions, Inc. Pittsburg, PA 412-492-8220

Vehicle Used: 15,000 lb vehicle traveling at 30 mph
Impact Angle between wall & vehicle: 90 degrees
Wall Used in Model:

- Two courses high by twenty courses long free-standing wall, with each block weighing 1,300 lb. The concrete was simulated to be 4,000 psi.
- The mechanical links embedded inside the wall were ¾" heavy-duty J-bolts placed between the two courses of free-standing wall and ¾" steel cables in each row of blocks.
- The vehicle was defined as an infinitely rigid block (meaning that the wall must absorb all of the kinetic energy introduced from the moving impactor) roughly the size and shape of the front bumper of a truck.

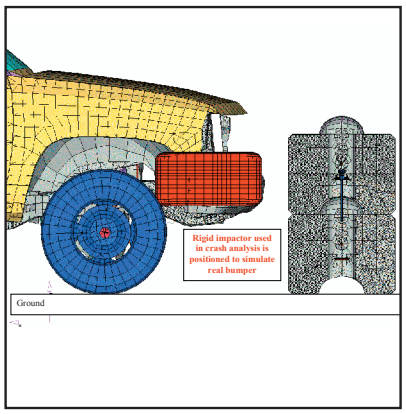
Results:

- The wall stopped the impactor within 12 feet.
- Even under the harsh condition of having the impactor come in contact near the top of the wall (a high hit), the "knob and groove" design details in the concrete blocks combined with the cabling system do a good job of keeping the wall from toppling over.

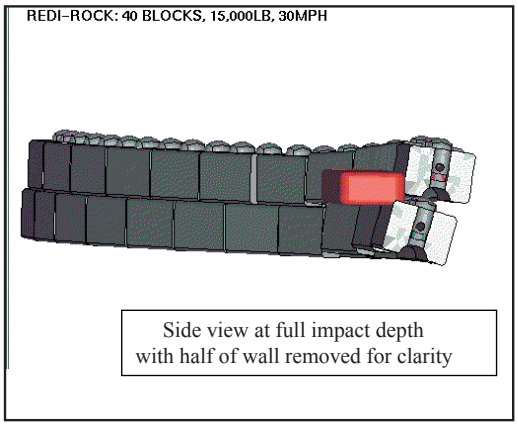
Conclusion:

"In this particular test, the wall stopped the impactor within 12 feet...[T]he wall-cabling system work[s] synergistically to force the impactor to drag more of the wall with it for every inch it penetrates and pushes the wall. It is this linking and dragging of the blocks that successfully stops the impactor."

Prior to Impact



Maximum Deformation



Side view at full impact depth with half of wall removed for clarity

Results Summary

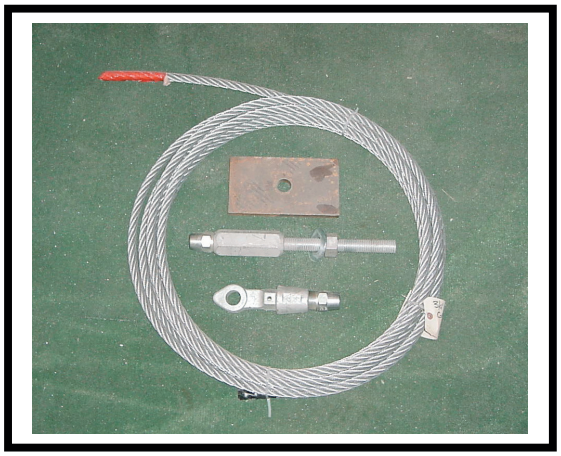
ENERGY ABSORBING COMPONENTS	PERCENTAGE OF ENERGY ABSORBED (%)
Concrete blocks	39.1
Cables	14.3
Vertical connections	1.2
Frictional loss	43.9
Ground anchors	N/A
Miscellaneous	1.5
TOTALS	***100.0%***

For computer simulations, visit www.redi-rock.com

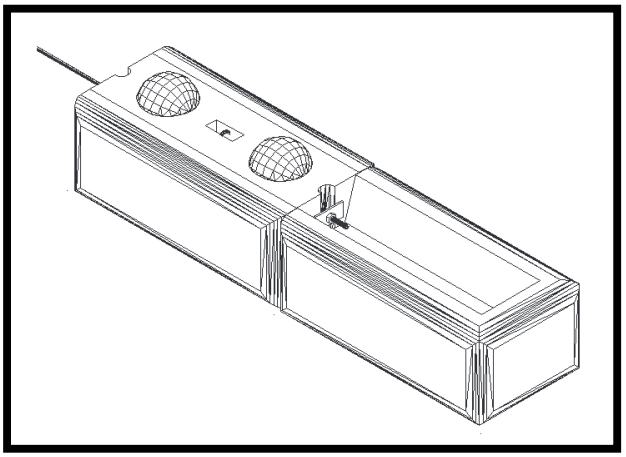
Post Tension Cable and Connections

	Size	Classification	Nominal Strength (lb)
Galvanized Wire Rope (USA)	$^3/_4$"	6 x 19 IWRC	58,800
	1"	6 x 19 IWRC	103,400
Wire Rope Terminations for 3/4" cable			
Coarse thread stud socket fitting (galvanized)			58,800
Eye Socket Fitting (galvanized)			58,800
Wedge and Ferrule			47,040
Drum Socket (zinc plated)			58,800
3/4" End Kit (items in **bold** included in End Kit)			
Wire Rope Terminations for 1" cable			
Coarse thread stud socket fitting (galvanized)			103,400
Eye Socket Fitting (galvanized)			103,400
Wedge and Ferrule			82,720
Drum Socket (zinc plated)			103,400
1" End Kit (items in **bold** included in End Kit)			

	Size
Steel Termination Plates (2)	$^5/_8$" x 6" x 9"



Galvanized Cable with Termination Ends and Steel Termination Plate



Post-Tension Cable and Termination End Installed in Blocks