CKR Engineers, Inc.
Consulting Structural Engineers

December 28, 2009

Mr. Brian Morrow
RhinoRock LLC
PO BOX 971178
Orem, Utah 84097

Re: 6 ft. RhinoRock Concrete Fence Testing

CKR File: 9536

Dear Brian:

This letter addresses the testing performed by RhinoRock LLC on the "RhinoRock" concrete fence panel. The "RhinoRock" panel measures 4-1/4 in. thick by 8 ft. - 4 in. wide by 6 ft. tall. The hollow panel consists of a thin fiber-reinforced concrete surface with strategically located composite ribs in the panel interior. See Photographs 1 to 4. For the complete fence system, the panels will be attached to precast concrete posts bearing on footings. This letter only addresses the load testing of the fence panel; it does not address the posts or footing system.

Panel Testing

1. CKR Engineers did not design the "RhinoRock" fence panel, nor have we performed a structural analysis of the panel. A total of 5 load tests were performed on the concrete panels. I observed the full test of panel #2. RhinoRock personnel performed and provided video records to our office of the other four tests.

2. The testing appears to have been completed in accordance with generally accepted materials engineering and testing principles and practices. No other warranty, either expressed or implied, is made by CKR Engineers. CKR Engineers is evaluating the information supplied by RhinoRock. RhinoRock takes responsibility for the testing data.

3. Each panel was tested by placing it horizontally and bearing the short ends on 6 in. wide continuous foam support pads. See Photograph 1. Approximately 4 to 5 in. of the panel was bearing on the foam. See Photographs 3 and 5. A 2x8 wood frame was placed on top of and around the perimeter of the panel for the first test. A plastic liner was placed inside the frame, and then the frame was slowly filled with water. For the remainder of the tests, a 2x4 wood frame was placed on top of the 2x8 frame to allow for more water depth. The panel in test #2 was loaded to failure. See Photograph 6. The other

remaining panels were not tested to failure. You showed me the panel used for test #1. There were no visible signs of cracking or distress in the panel after the test. You informed me that panels 3, 4 and 5 also did not show any signs of cracking or distress.

4. The following table summarizes the testing data.

Test	Average Depth of Water	Weight of Water	Weight of Panel*	Total Load	Tested to Failure
1	8 in.	42 psf	5 psf	47 psf	No
2	12 – ¾ in.	66 psf	5 psf	71 psf	Yes
3	9 – ¾ in.	50 psf	5 psf	55 psf	No
4	9 in.	46 psf	5 psf	51 psf	No
5	9 – ½ in.	49 psf	5 psf	53 psf	No

1. *Weight of panel supplied by RhinoRock personnel.

5. Based upon our evaluation of the supplied testing data, we recommend that the panel be limited to a maximum allowable wind pressure of 44 psf. This number is calculated by taking the 71 psf ultimate load from test #2 and dividing it by a factor of safety of 1.6.
6. This testing data recommendation is limited to the panel only. The suitability of this panel in a particular location to resist potential applied loads (wind, seismic, impact) should be evaluated by a qualified structural engineer. Care should be taken to insure that the panel is installed plumb, and properly attached to the concrete precast posts.

Fence Wind Pressures

The pressure imposed upon a fence by the wind is a function of the wind speed, exposure and aspect ratio of the fence. The 2006 *International Building Code* references the American Society of Civil Engineers document *ASCE 7-05 Minimum Design Loads for Buildings and Other Structures* for wind pressures. Included with this letter are calculations for a number of different wind speeds and exposures using the requirements of ASCE 7-05. It should be noted that wind pressures on a fence are higher at a free end of a fence than in an interior portion of the fence. The following table summarizes the calculated pressures.

Wind Speed	Exposure	End Pressure End to 6 ft	End Pressure 6 ft to 12 ft.	End Pressure 12 ft. to 18 ft.	Interior Pressure > 30 ft.
90 mph	B	25.8 psf	15.3 psf	11.7 psf	10.0 psf
100 mph	B	31.8 psf	18.9 psf	14.4 psf	12.0 psf
110 mph	B	38.5 psf	22.8 psf	17.5 psf	14.6 psf
120 mph	B	45.8 psf	27.2 psf	20.8 psf	17.3 psf
90 mph	C	38.1 psf	22.6 psf	17.3 psf	14.4 psf
100 mph	C	47.0 psf	27.9 psf	21.3 psf	17.8 psf
110 mph	C	**56.9 psf**	33.7 psf	25.8 psf	21.5 psf

2. Pressures are calculated assuming the fence is not located on the upper portion of a hill or escarpment.
3. End pressures are calculated assuming a minimum 270 ft. long fence with no corners.

From this chart it can be observed that most installations of the RhinoRock fence panel will be adequate in a 120 mph exposure B, or 100 mph exposure C wind. Installations at the top of hill or escarpment or in areas where the wind speed or exposure are higher than shown may be possible depending on the configuration of the fence. The presence of a corner near the free end of a fence may possibly reduce the significant end pressures that develop. We recommend that each fence installation be evaluated by a qualified structural engineer on a case by case basis.

Please call if you have questions.

Sincerely,

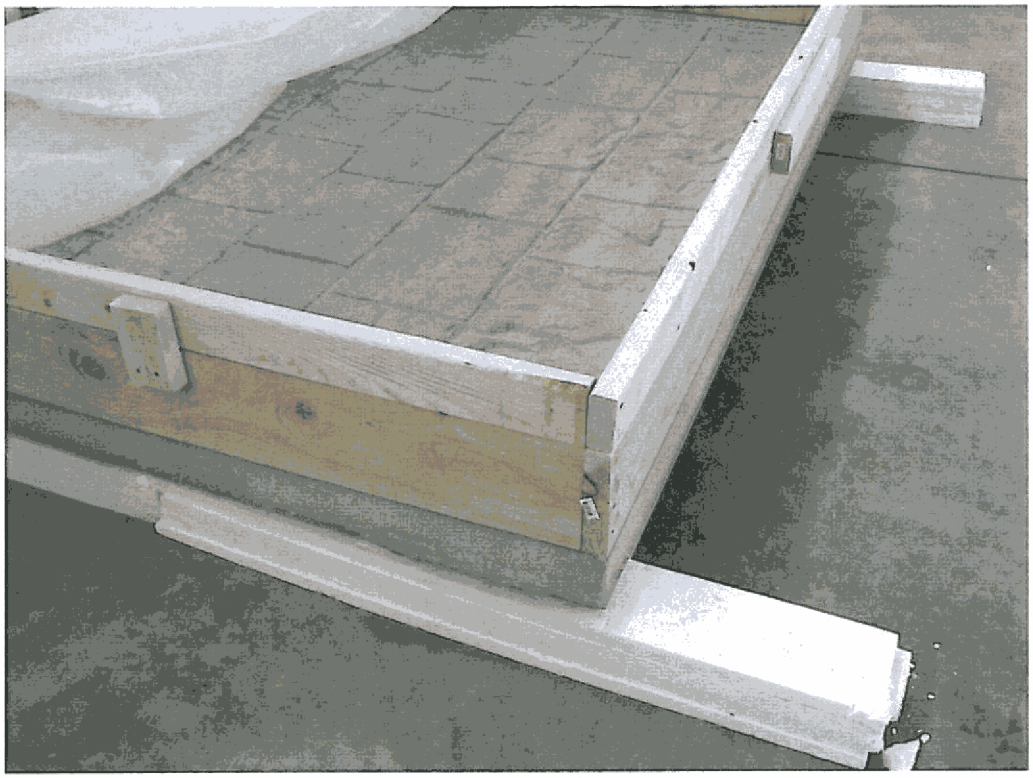
Daniel D. Goodrich, S.E.

PROFESSIONAL STRUCTURAL ENGINEER
No. 295696
DANIEL D. GOODRICH
STATE OF UTAH

Reviewed,

Steven J. Cosper, S.E.

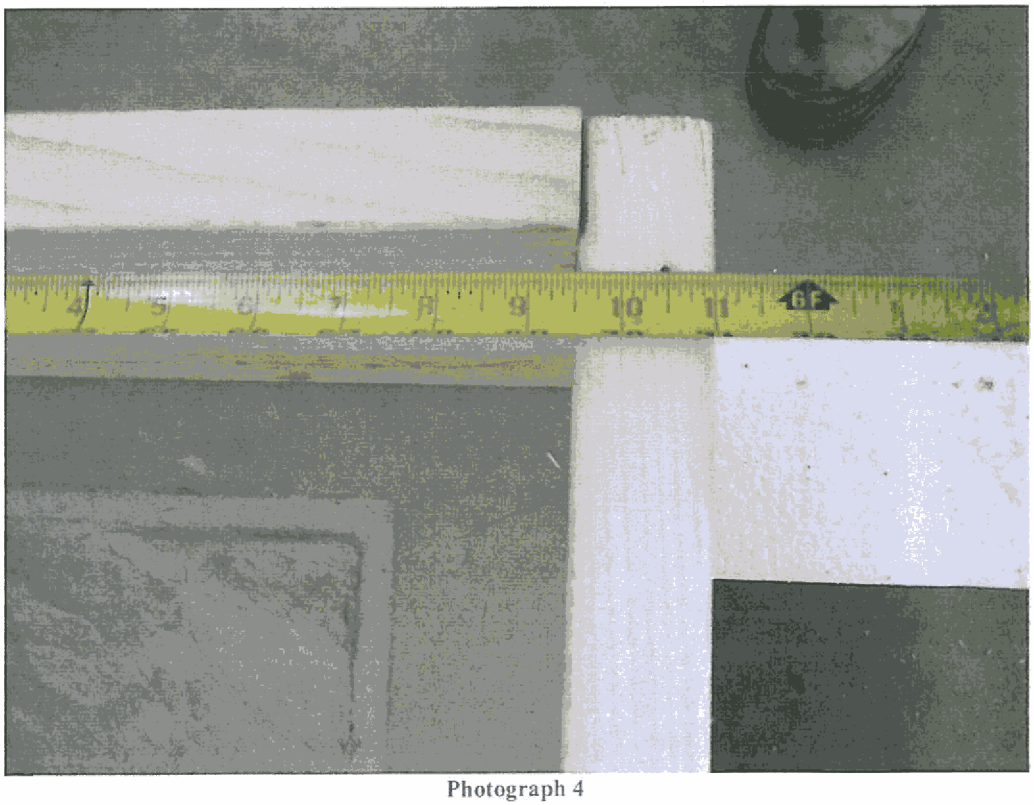
Encl.



Photograph 1

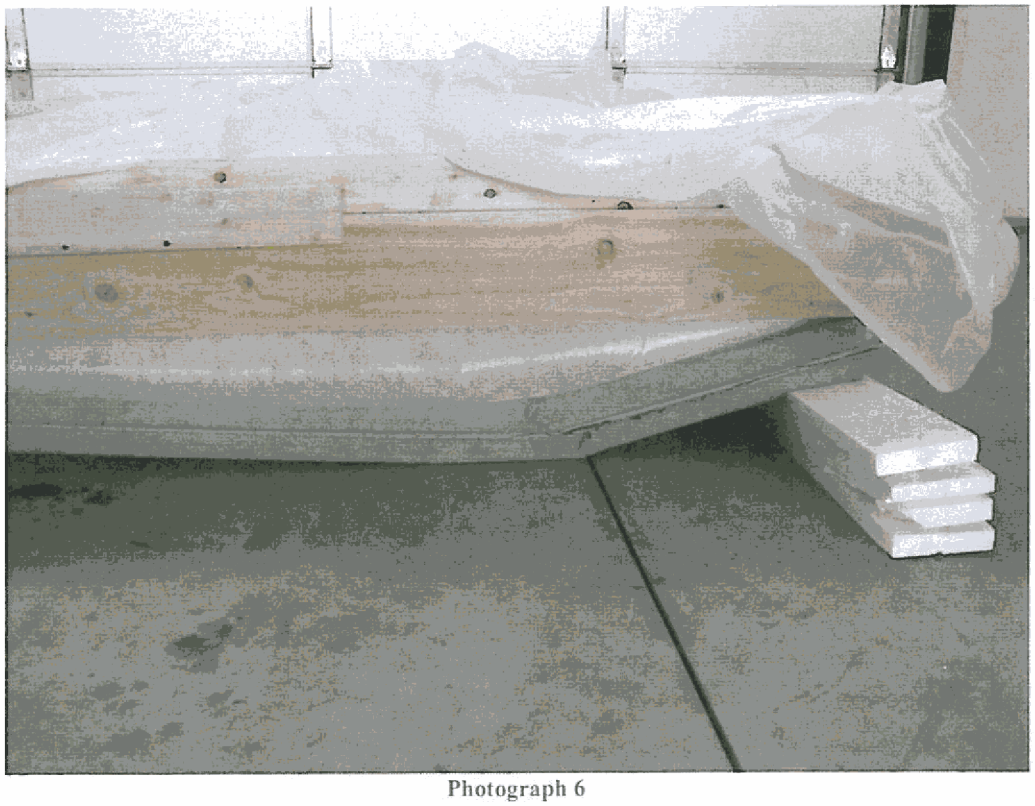
Photograph 2

Photograph 3



Photograph 4

Photograph 5



Photograph 6

ASCE 7-05 Wind

Section 6.5.14 – Design Wind loads on solid freestanding walls

Project: Rhino Fence
Location:
Job: 9536

Step 1.	V =	90	Mph	← WIND SPEED
	K_d =	0.85	Table 6-4	
Step 2.	I =	0.87	Table 6-1	← IMPORTANCE FACTOR
Step 3.	Exp.	B	Section 6.5.6	← EXPOSURE
	Wall height h =	6	(ft)	
	K_h =	0.57	Table 6-3	
Step 4.	K_{zt} =	1	Figure 6-4	← NO HILL OR ESCARPMENT.
Step 5.	G =	0.85	Section 6.5.8	
Step 9.	q_h =	8.8	psf	← C_f VARIES WITH ASPECT RATIO OF FENCE
Step 10.	F =	7.5	* C_f * As	

Case A & B

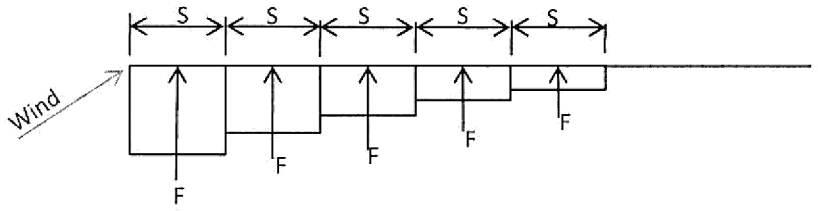
	C_f =	1.3	← INTERIOR PRESSURE
	F =	9.74	psf **Use 10 psf minimum.**

Case C

		Reduction Factor	Modified C_f	Final Wall Pressure	
0 to S	4.3	0.8	3.44	**25.8**	psf
S to 2S	2.55	0.8	2.04	**15.3**	psf
2S to 3S	1.95	0.8	1.56	**11.7**	psf
3S to 4S	1.85	0.8	1.48	**11.1**	psf
4S to 5S	1.85	0.8	1.48	**11.1**	psf
5S to 10S	1.1	0.8	0.88	**6.6**	psf

← MAX PRESSURE @ FENCE END.

Case C only controls at the ends of the fence. Case A & B control for interior portions.



ASCE 7-05 Wind

Section 6.5.14 – Design Wind loads on solid freestanding walls

Project: Rhino Fence
Location:
Job: 9536

Step 1.	V =	100	Mph
	K_d =	0.85	Table 6-4
Step 2.	I =	0.87	Table 6-1
Step 3.	Exp.	B	Section 6.5.6
	Wall height h =	6	(ft)
	K_h =	0.57	Table 6-3
Step 4.	K_{zt} =	1	Figure 6-4
Step 5.	G =	0.85	Section 6.5.8
Step 9.	q_h =	10.9	psf
Step 10.	F =	9.2	* C_f * As

Case A & B

C_f =	1.3		
F =	12.02	psf	**Use 10 psf minimum.**

Case C

		Reduction Factor	Modified C_f	Final Wall Pressure	
0 to S	4.3	0.8	3.44	**31.8**	psf
S to 2S	2.55	0.8	2.04	**18.9**	psf
2S to 3S	1.95	0.8	1.56	**14.4**	psf
3S to 4S	1.85	0.8	1.48	**13.7**	psf
4S to 5S	1.85	0.8	1.48	**13.7**	psf
5S to 10S	1.1	0.8	0.88	**8.1**	psf

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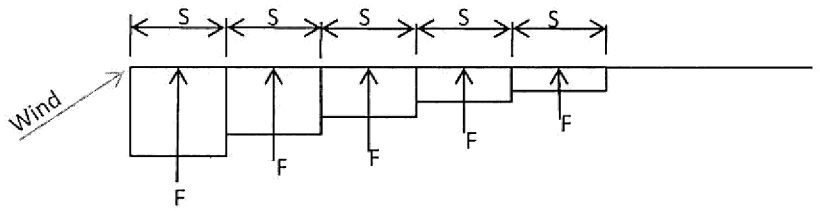


ASCE 7-05 Wind

Section 6.5.14 – Design Wind loads on solid freestanding walls

Project: Rhino Fence
Location:
Job: 9536

Step 1.	V =	110	Mph	
	K_d =	0.85	Table 6-4	
Step 2.	I =	0.87	Table 6-1	
Step 3.	Exp.	B	Section 6.5.6	
	Wall height h =	6	(ft)	
	K_h =	0.57	Table 6-3	
Step 4.	K_{zt} =	1	Figure 6-4	
Step 5.	G =	0.85	Section 6.5.8	
Step 9.	q_h =	13.2	psf	
Step 10.	F =	11.2	* C_f * As	

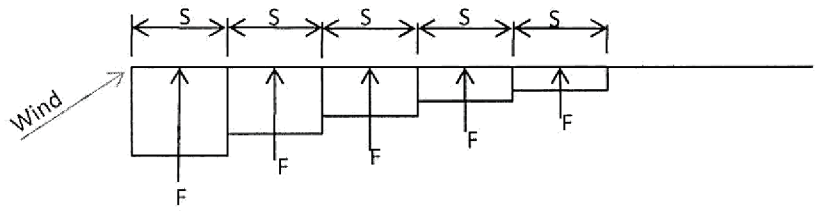
Case A & B

C_f =	1.3		
F =	14.55	psf	**Use 10 psf minimum.**

Case C

		Reduction Factor	Modified C_f	Final Wall Pressure	
0 to S	4.3	0.8	3.44	**38.5**	psf
S to 2S	2.55	0.8	2.04	**22.8**	psf
2S to 3S	1.95	0.8	1.56	**17.5**	psf
3S to 4S	1.85	0.8	1.48	**16.6**	psf
4S to 5S	1.85	0.8	1.48	**16.6**	psf
5S to 10S	1.1	0.8	0.88	**9.8**	psf

Case C only controls at the ends of the fence. Case A & B control for interior portions.



ASCE 7-05 Wind

Section 6.5.14 – Design Wind loads on solid freestanding walls

Project: Rhino Fence
Location:
Job: 9536

Step 1.	V =	120	Mph
	K_d =	0.85	Table 6-4
Step 2.	I =	0.87	Table 6-1
Step 3.	Exp.	B	Section 6.5.6
	Wall height h =	6	(ft)
	K_h =	0.57	Table 6-3
Step 4.	K_{zt} =	1	Figure 6-4
Step 5.	G =	0.85	Section 6.5.8
Step 9.	q_h =	15.7	psf
Step 10.	F =	13.3	* C_f * As

Case A & B

C_f =	1.3		
F =	17.31	psf	**Use 10 psf minimum.**

Case C

		Reduction Factor	Modified C_f	Final Wall Pressure	
0 to S	4.3	0.8	3.44	**45.8**	psf
S to 2S	2.55	0.8	2.04	**27.2**	psf
2S to 3S	1.95	0.8	1.56	**20.8**	psf
3S to 4S	1.85	0.8	1.48	**19.7**	psf
4S to 5S	1.85	0.8	1.48	**19.7**	psf
5S to 10S	1.1	0.8	0.88	**11.7**	psf

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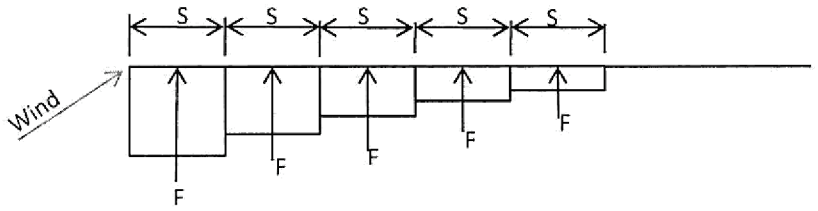

ASCE 7-05 Wind

Section 6.5.14 – Design Wind loads on solid freestanding walls

Project: Rhino Fence
Location:
Job: 9536

Step 1.	V =	90	Mph
	K_d =	0.85	Table 6-4
Step 2.	I =	0.87	Table 6-1
Step 3.	Exp.	C	Section 6.5.6
	Wall height h =	6	(ft)
	K_h =	0.85	Table 6-3
Step 4.	K_{zt} =	1	Figure 6-4
Step 5.	G =	0.85	Section 6.5.8
Step 9.	q_h =	13.0	psf
Step 10.	F =	11.1	* C_f * As

Case A & B

	C_f =	1.3	
	F =	14.38	psf **Use 10 psf minimum.**

Case C

		Reduction Factor	Modified C_f	Final Wall Pressure	
0 to S	4.3	0.8	3.44	**38.1**	psf
S to 2S	2.55	0.8	2.04	**22.6**	psf
2S to 3S	1.95	0.8	1.56	**17.3**	psf
3S to 4S	1.85	0.8	1.48	**16.4**	psf
4S to 5S	1.85	0.8	1.48	**16.4**	psf
5S to 10S	1.1	0.8	0.88	**9.7**	psf

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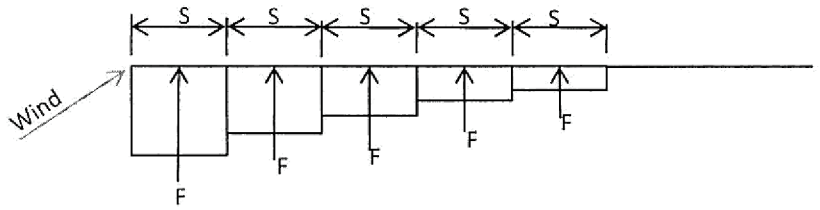

ASCE 7-05 Wind

Section 6.5.14 – Design Wind loads on solid freestanding walls

Project: Rhino Fence
Location:
Job: 9536

Step 1.	V =	100	Mph	
	K_d =	0.85	Table 6-4	
Step 2.	I =	0.87	Table 6-1	
Step 3.	Exp.	C	Section 6.5.6	
	Wall height h =	6	(ft)	
	K_h =	0.85	Table 6-3	
Step 4.	K_{zt} =	1	Figure 6-4	
Step 5.	G =	0.85	Section 6.5.8	
Step 9.	q_h =	16.1	psf	
Step 10.	F =	13.7	* C_f * As	

Case A & B

C_f =	1.3		
F =	17.76	psf	**Use 10 psf minimum.**

Case C

		Reduction Factor	Modified C_f	Final Wall Pressure	
0 to S	4.3	0.8	3.44	**47.0**	psf
S to 2S	2.55	0.8	2.04	**27.9**	psf
2S to 3S	1.95	0.8	1.56	**21.3**	psf
3S to 4S	1.85	0.8	1.48	**20.2**	psf
4S to 5S	1.85	0.8	1.48	**20.2**	psf
5S to 10S	1.1	0.8	0.88	**12.0**	psf

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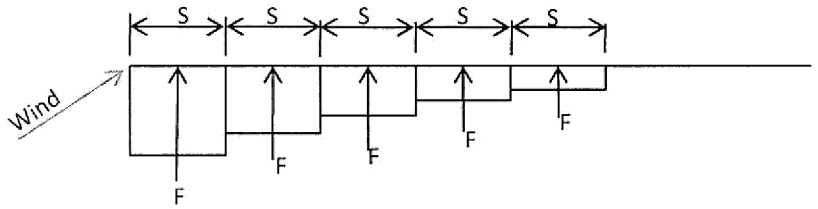

ASCE 7-05 Wind

Section 6.5.14 – Design Wind loads on solid freestanding walls

Project: Rhino Fence
Location:
Job: 9536

Step 1.	V =	110	Mph	
	K_d =	0.85	Table 6-4	
Step 2.	I =	0.87	Table 6-1	
Step 3.	Exp.	C	Section 6.5.6	
	Wall height h =	6	(ft)	
	K_h =	0.85	Table 6-3	
Step 4.	K_{zt} =	1	Figure 6-4	
Step 5.	G =	0.85	Section 6.5.8	
Step 9.	q_h =	19.4	psf	
Step 10.	F =	16.5	* C_f * As	

Case A & B

C_f =	1.3		
F =	21.49	psf	**Use 10 psf minimum.**

Case C

		Reduction Factor	Modified C_f	Final Wall Pressure	
0 to S	4.3	0.8	3.44	**56.9**	psf
S to 2S	2.55	0.8	2.04	**33.7**	psf
2S to 3S	1.95	0.8	1.56	**25.8**	psf
3S to 4S	1.85	0.8	1.48	**24.5**	psf
4S to 5S	1.85	0.8	1.48	**24.5**	psf
5S to 10S	1.1	0.8	0.88	**14.5**	psf

Case C only controls at the ends of the fence. Case A & B control for interior portions.