

TESTING OF STRAW BALE WALLS WITH OUT OF PLANE LOADS

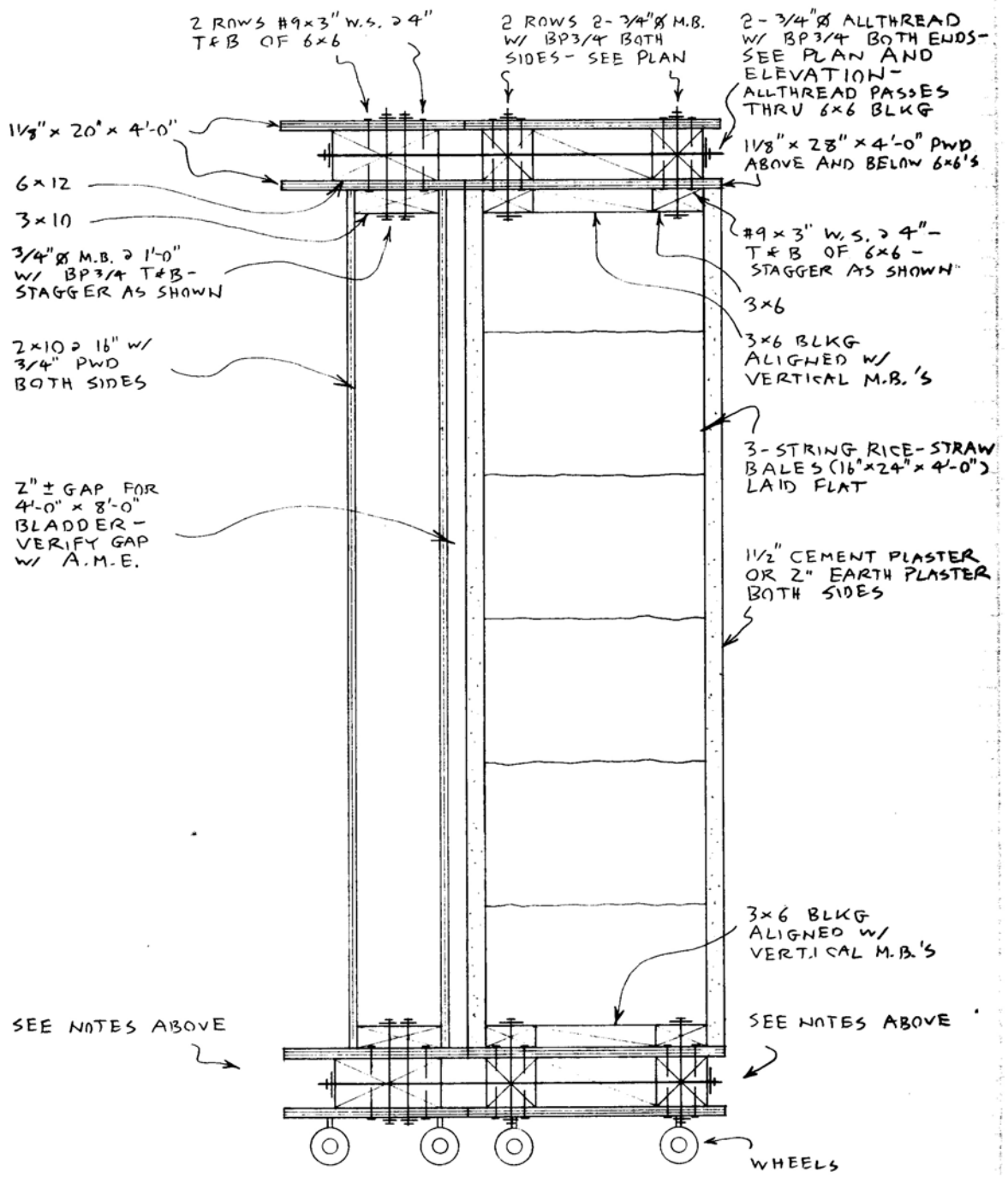
December 8, 2003
Kevin Donahue, SE

PRELIMINARY REPORT

3-string rice-straw bales (16" x 24" x 4'-0") laid flat and stacked to create 2'x4'x8' straw bale walls plastered with 1" stucco, 2" earth plaster or unplastered were loaded out-of-plane as follows: air-pressure was added to a 4'x8' plastic waterbed bladder placed in a 2" gap between a 4'x8' 2x10@16" stud wall with 3/4" plywood both sides. The straw bale wall was attached to the wood stud wall as per the specification drawing below. Note that all top and bottom plates of the straw bale walls were bolted to the rig with 2-3/4" machine bolts with BP3/4 plate washers each bolt. Air pressure was added to the bladder with a compressor attached in line to a Dwyer Magnehelic Differential Pressure Gage. After several seconds of pressurization, the compressor was shut off and a pressure reading was taken from the gage. The reading measured the differential pressure in the high-pressure chamber (attached to the bladder) over the atmospheric pressure in the room. This value represented the net pressure exerted from the bladder to the wall in the out-of-plane direction. Pressure gage values were given in inches of water, where one inch of water equals 5.2 pounds per square foot of pressure. Pressure was added to the bladder in approximately 4 inches of water increments with at least 15 seconds between load applications.

Earth plaster was plaster mix D from the plaster testing program. This plaster consisted of 1 part dry clay-soil mixed with enough water to create workable clay-slip, 1.5 parts plaster sand and 1.5 parts chopped rice straw. The clay-soil consisted of 17% sand, 31% silt and 52% clay. Refer to the plaster testing report for further details.

Stucco was made from Quikrete "Exterior Stucco Mix" (no. 1209) consisting of 1 part plastic cement to 3 parts plaster sand.



OUT-OF-PLANE RIG DOCKED W/ S.B. WALL
3/4" = 1'-0"



Rig docked to cement-plaster (stucco) straw-bale wall

OUT-OF-PLANE TEST 1: STUCCO WITH WWF MESH

Specifications apply to both sides

Plaster: 1 inch stucco applied in 2 coats

Plaster reinforcement: 2x2x14ga welded wire fabric stucco mesh

Top and bottom connection: 16ga 7/16" crown x 1.75" leg staples @ 2" and

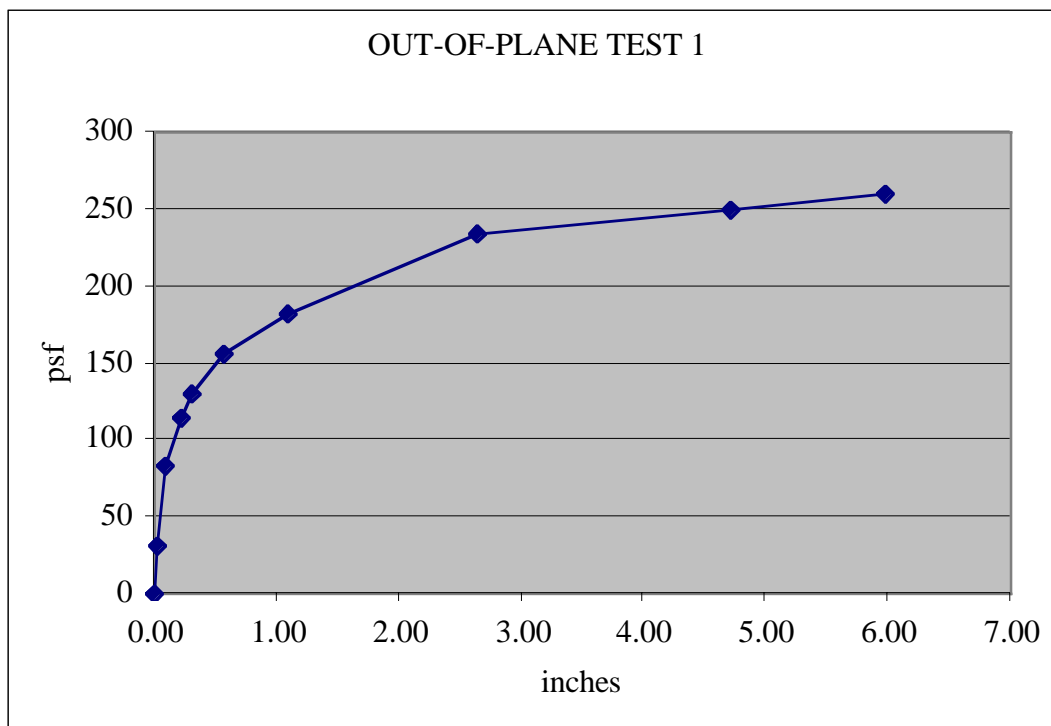
SDS1/4x3" screws @ 8" w/ std washer over BP1/2 ea screw

Top and bottom plates: 4x4

Deflection Mid-ht (in.)	Pressure (psf)	Pressure (inches H2O)
0.00	0	0
0.03	31	6
0.09	83	16
0.22	114	22
0.31	130	25
0.56	156	30
1.09	182	35
2.63	234	45
4.72	250	48
5.97	260	50

cracking

failed at 52 (270 psf)



OUT-OF-PLANE TEST 2: STUCCO WITH HEX WOVEN LATH

Specifications apply to both sides except as noted

Plaster: 1 inch stucco applied in 2 coats

Plaster reinforcement: 17ga x 1.5" hexagonal woven wire lath

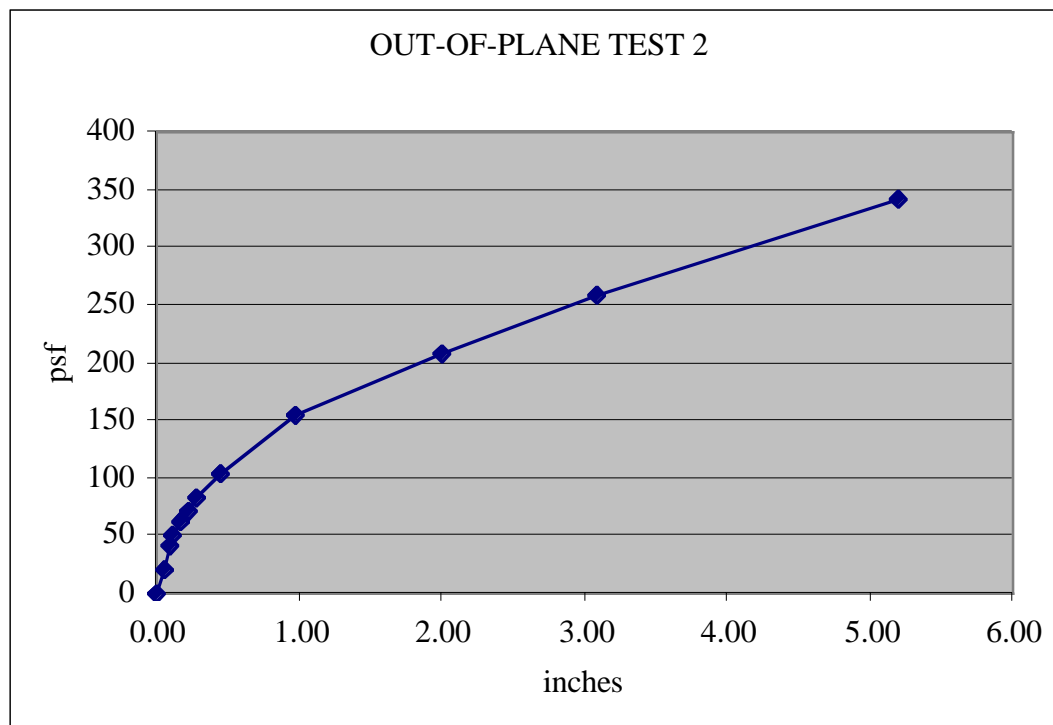
Top and bottom connection: 16ga 1/2" crown x 1.25" leg staples @ 6" and

SDS1/4x3" screws @ 8" w/ std washer over BP1/2 ea screw

Top plate: 4X6 on edge on loaded side and 2x6 flat unloaded side

Bottom plate: 2x4 both sides

Deflection Mid-ht (in.)	Pressure (psf)	Pressure (inches H2O)	
0.00	0	0	
0.06	21	4	
0.09	42	8	
0.12	52	10	
0.16	62	12	
0.22	73	14	
0.28	83	16	
0.44	104	20	cracking
0.97	156	30	
2.00	208	40	
3.09	260	50	
5.19	343	66	no failure



OUT-OF-PLANE TEST 3: STUCCO WITH 1% STEEL FIBERS

Specifications apply to both sides

Plaster: 1 inch stucco applied in 2 coats

Plaster reinforcement: 1% 1.5" Xorex steel fibers by volume (13 lbs per side)

Xorex specs: deformed 0.045"x1.5" 120ksi fibers

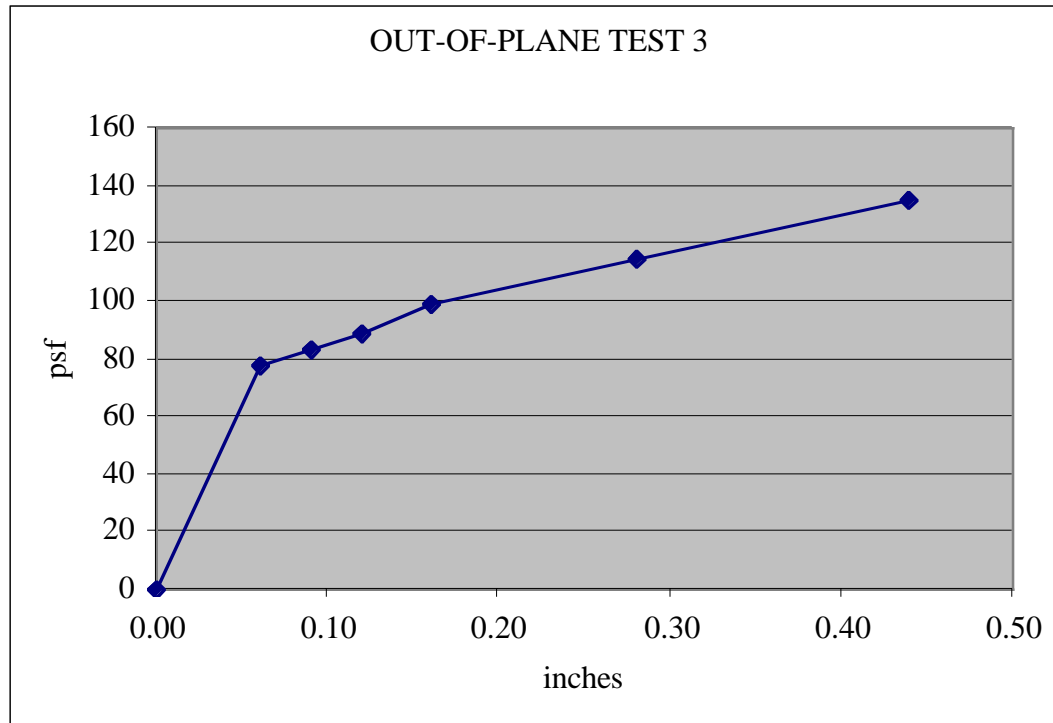
Top and bottom connection: SDS1/4x3" screws @ 8" w/ std washer over BP1/2 ea screw

Top and bottom plates: 4x4

Deflection Mid-ht (in.)	Pressure (psf)	Pressure (inches H2O)
0.00	0	0
0.06	78	15
0.09	83	16
0.12	88	17
0.16	99	19
0.28	114	22
0.44	135	26

first cracking

sudden failure at 28 (146 psf)



OUT-OF-PLANE TEST 4: STUCCO WITH 0.8% STEEL FIBERS

Specifications apply to both sides

Plaster: 1 inch stucco applied in 2 coats

Plaster reinforcement: 0.8% 2" Xorex steel fibers by volume (10.5 lbs per side)

Xorex specs: deformed 0.045" x 2.0" 120ksi fibers

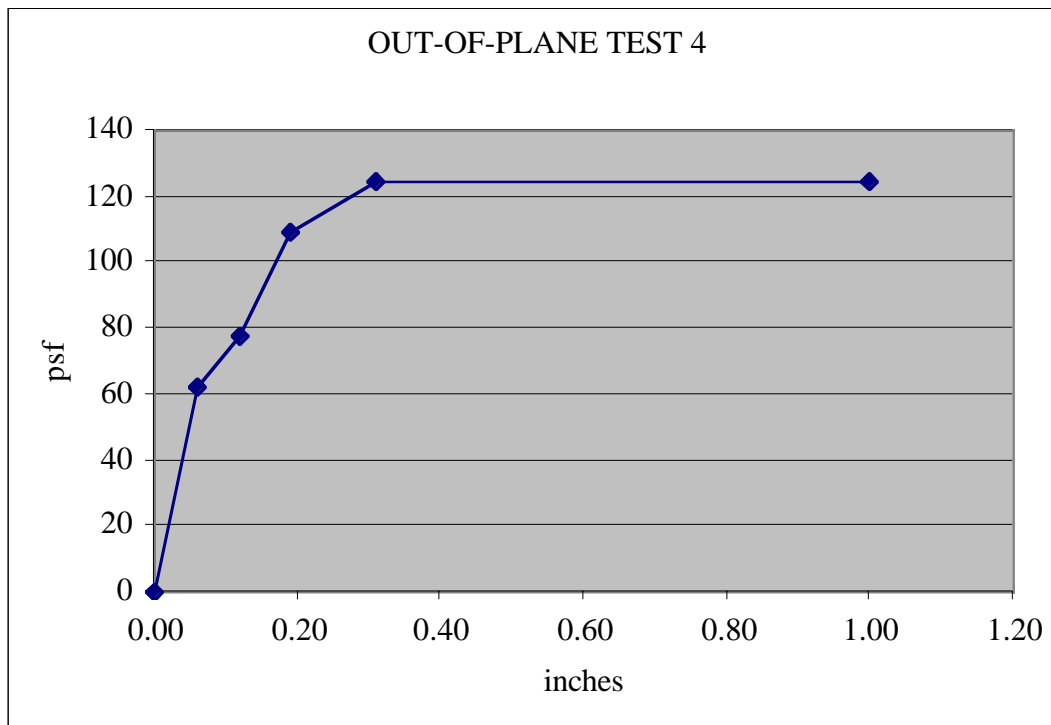
Top connection: none (loaded side bears laterally against top plate)

Bottom connection: 2x2x14ga welded wire fabric stucco mesh wrapped between 2-2x4 bottom plate and extending 12" into plaster

Top plate: 4x6 w/ 1/2"pwd t&b box beam

Bottom plate: 2-2x4 (w/ mesh wrap in between)

Deflection Mid-ht (in.)	Pressure (psf)	Pressure (inches H2O)
0.00	0	0
0.06	62	12
0.12	78	15
0.19	109	21
0.31	125	24
1.00	125	24



OUT-OF-PLANE TEST 5: EARTH PLASTER W/ MESH AND FULL TIES

Specifications apply to both sides

Plaster: 2 inch earth plaster applied in 1 coat

Plaster reinforcement: 2x2x0.047" Cintoflex C plastic mesh

Thru ties: 2 loops (of 2) baling twine spaced @ 24" ea course (7 courses) tied to 5/8" x 4' horizontal bamboo dowels outside mesh both sides

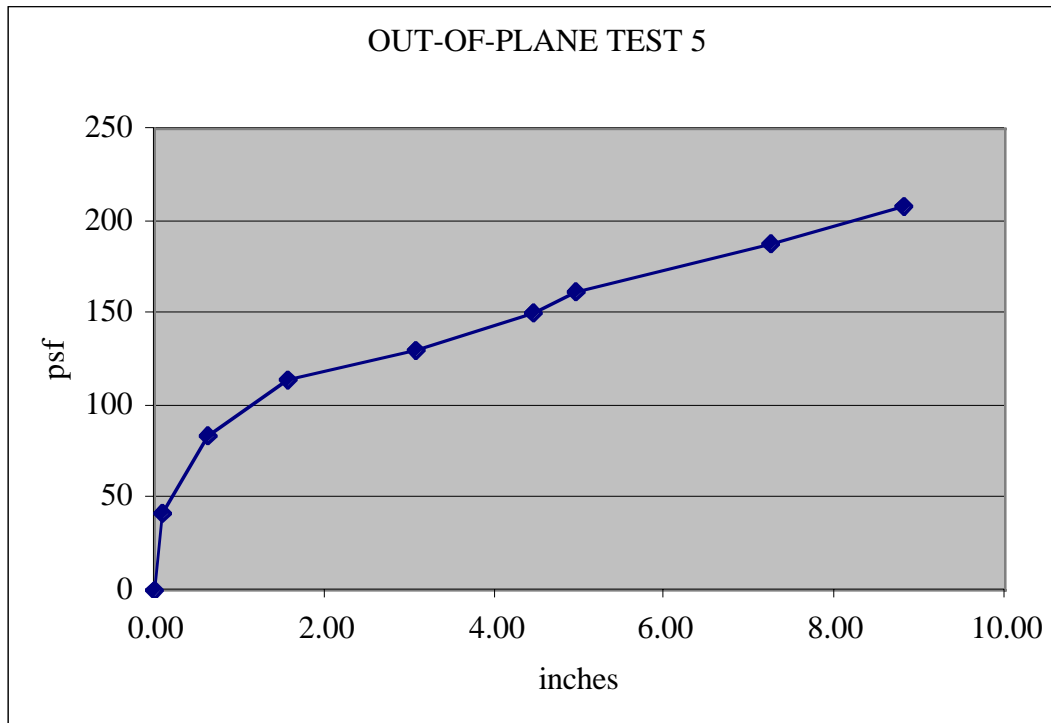
Top connection: 16ga 7/16" crown x 1.75" leg staples @ 2" w/ added 14" mesh strip stapled @ 2"

Bottom connection: mesh wrapped under 4x4 plate (and cont. to top both sides) w/ added 14" mesh strip stapled @ 2"

Top plate: 4x6 on edge

Bottom plate: 3x4

Deflection Mid-ht (in.)	Pressure (psf)	Pressure (inches H2O)
0.00	0	0
0.09	42	8
0.62	83	16
1.56	114	22
3.06	130	25
4.44	151	29
4.94	161	31
7.25	187	36
8.81	208	40



OUT-OF-PLANE TEST 6: EARTH PLASTER W/ MESH AND PARTIAL TIES

Plaster: 2 inch earth plaster applied in 1 coat

Plaster reinforcement: 2x2x0.047" Cintoflex C plastic mesh

Thru ties: 2 loops (of 2) baling twine spaced at 24" above the 2nd and 4th courses (third points)
tied to 5/8" x 8' vertical bamboo dowels outside mesh both sides

Top connection: 16ga 7/16" crown x 1.75" leg staples @ 2"
w/ added 14" mesh strip stapled @ 2"

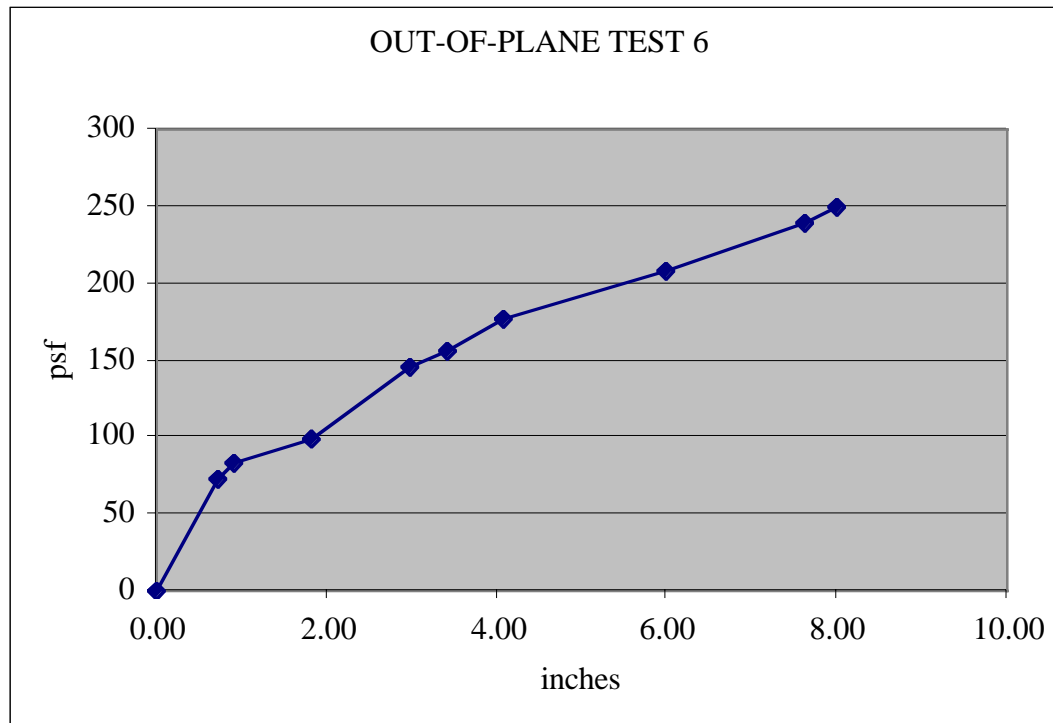
Bottom connection: mesh wrapped under 4x4 plate (and cont. to top both sides)
w/ added 14" mesh strip stapled @ 2"

Top plate: 4x6 on edge Bottom plate: 3x4

Deflection Mid-ht (in.)	Pressure (psf)	Pressure (inches H2O)
0.00	0	0
0.72	73	14
0.91	83	16
1.81	99	19
2.97	146	28
3.41	156	30
4.06	177	34
6.00	208	40
7.63	239	46
8.00	250	48

top failed at 29 (151 psf) below connection

failed at 52 (270 psf)



OUT-OF-PLANE TEST 7: EARTH PLASTER W/ STAPLED MESH

Specifications apply to both sides

Plaster: 2 inch earth plaster applied in 1 coat

Plaster reinforcement: 2x2x0.047" Cintoflex C plastic mesh

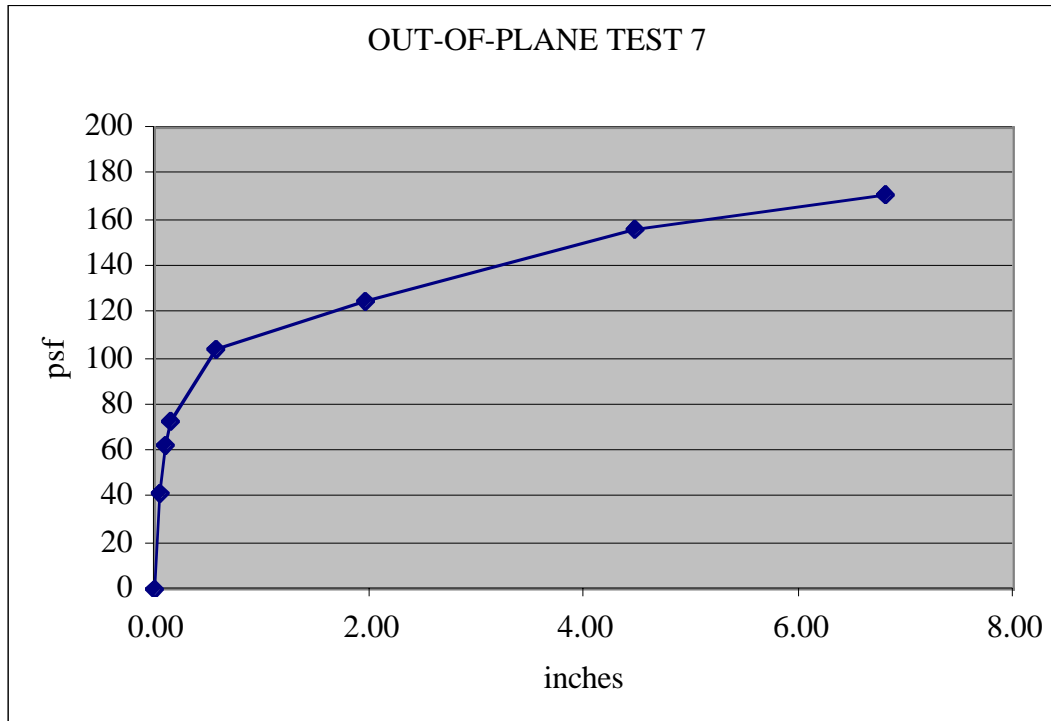
Thru ties: none

Top and bottom connection: 16ga 7/16" crown x 1.75" leg staples @ 2"
w/ added 14" mesh strip stapled @ 2"

Top plate: 4x6 on edge

Bottom plate: 3x4

Deflection Mid-ht (in.)	Pressure (psf)	Pressure (inches H2O)
0.00	0	0
0.06	42	8
0.09	62	12
0.16	73	14
0.56	104	20
1.97	125	24
4.47	156	30
6.81	172	33



OUT-OF-PLANE TEST 8: STAPLED MESH ONLY (NO PLASTER)

Specifications apply to both sides

Plaster: none

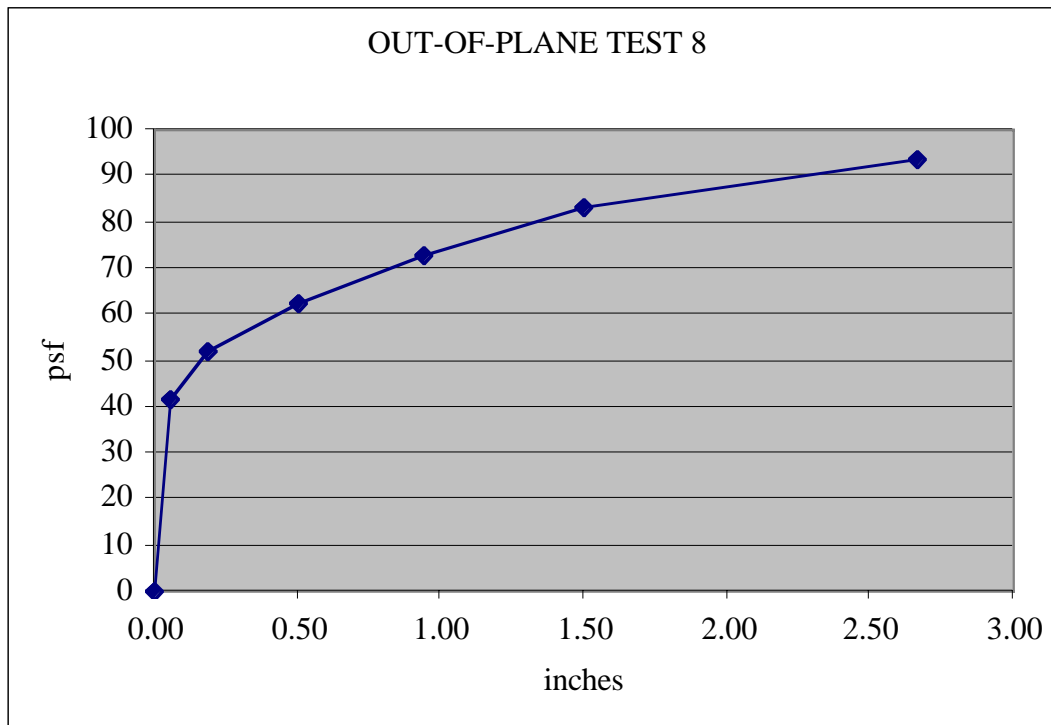
Mesh: 2x2x14ga welded wire fabric stucco mesh

Top and bottom connection: 16ga 7/16" crown x 1.25" leg staples @ 8"

Top and bottom plates: 4x4

Deflection Mid-ht (in.)	Pressure (psf)	Pressure (inches H2O)
0.00	0	0
0.06	42	8
0.19	52	10
0.50	62	12
0.94	73	14
1.50	83	16
2.66	94	18

failed at 20 (104 psf)



Kevin Donahue, SE

Email:kdse@sbcglobal.net