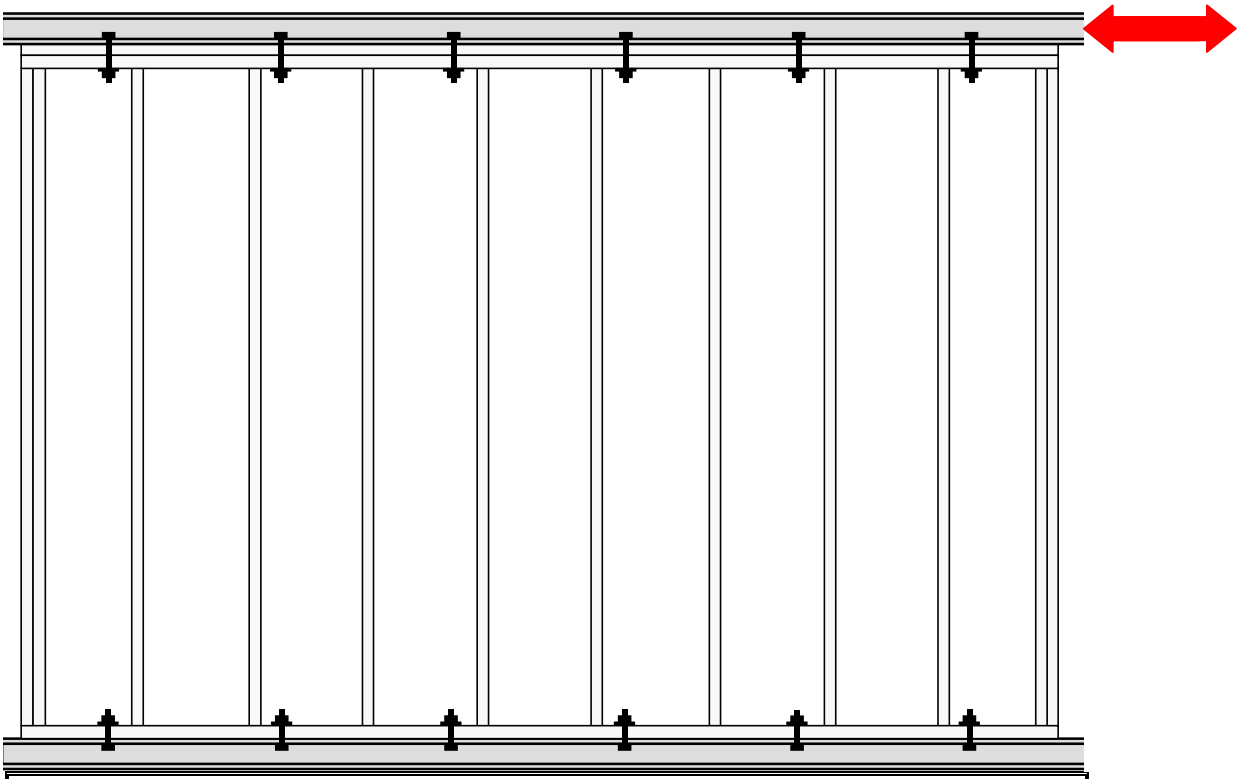
Walls 12IAc



Walls:	12IAc1	12IAc1re	12IAc2	12IAc2r
Manufactured:	**June 23, 1998**[1]	**June 23, 1998**	**June 23, 1998**[1]	**June 23, 1998**
MOE data files:	12nac1p.prn 12nac1s.prn	12iac1p2.prn 12nac1s.prn	12nac2p.prn 12nac2s.prn	12iacp3.prn 12nac2s.prn
MOE_{plates} (10^6 psi)	1.93	1.99	1.78	1.82
MOE_{studs} (10^6 psi)	1.41	1.41	1.38	1.38
$Density_{plates}$ (kg/m^3)	533	550	490	484
$Density_{studs}$ (kg/m^3)	447	447	448	448
Date tested:	**July 31, 1998**	**Aug. 1, 1998**[2]	**Aug. 19, 1998**	**Aug. 19, 1998**[3]
Time tested:	14:03	15:51	17:18	10:57
LTC files:	30alex12	30alex12	30alex12	30alex12
Data files:	12IAc1.dat	12IAc1re.dat	12IAc2.dat	12IAc2r.dat
Excel files:	12IAc1_data 12IAc1_UTP	12IAc1re_data 12IAc1re_UTP	12IAc2_data 12IAc2_UTP	12IAc2r_data 12IAc2r_UTP
Photo files:	673-681	682-700	no pictures	no pictures

[1] Sheathing attached with ¾-in. edge distance along the top and bottom plates.

[2] New bottom plate was attached 1 hour before the test. Sheathing attached to the bottom plate at 3 in. o. c. with ½ to ¾-in. edge distance.

[3] New bottom plate was attached 1 hour before the test. Sheathing attached to the bottom plate at 6 in. o. c. with ¾-in. edge distance.

Wall 12IAc1

Observations: The wall exhibited similar initial stiffness and capacity to monotonically tested walls 12IAm1 and 12IAm2. It reached similar peak load (4995 lbf.) at the negative 1.2-in. displacement. On the positive stroke, the load dropped 550 lbf. and the peak load never repeated. Brittle failure occurred at 1.5-in. amplitude. Sheathing unzipped from the bottom plate very quickly and the rest of the wall 'walked' away from the foundation as a rigid body (Photo 677). The test was stopped at 2.1-in. amplitude when the wall separated from the bottom plate entirely. No nail fatigue was observed. All sheathing nails tore through the edge at the bottom (Photos 673-676). Sheathing nails bent very little at the ends of the bottom plate (Photo 679). The rest of the sheathing moved relative to the studs and top plate less than 0.15 in. as graphs show. Uplift displacement of studs was symmetrical until failure as shown on graphs. Caster tracks are shown in Photos 680-681.

Instrumentation: LVDT #2 was added to measure uplift movement at 48 in. LVDT #3 measured uplift at 96 in. Sampling rate was 25 Hz.

Wall 12IAc1re

Rationale: After the test of wall 12IAc1, the wall remained almost intact except for the bottom plate and unzipped sheathing at the bottom. Sheathing moved relative to studs less than 0.15 in. and it was assumed that the sheathing connections might have original capacity. Similar to other tests of retrofitted walls, the idea of the test was to test the performance of a wall repaired after a seismic event. A new bottom plate was installed and sheathing nails were driven along the bottom at 3 in. o. c. Edge distance was 1/2 to 3/4 in.

The test was conducted 1 hour after the repair.

Observations: The stabilized stiffness equaled the initial stiffness of the wall and less than during the first test (12IAc1) and monotonic tests. Obviously, this was effect of the loading history of the perimeter nails. However, the wall developed 30% higher average peak load (6155 lbf.) at 1.5-in. amplitude and yielded up to 2.4-in. deflection. Failure mode, the bottom plate snapped on both ends of the wall and split under sheathing nails at the second and the third panels (Photos 695-696, 700). Therefore, uplift displacement of the intermediate studs was higher on the negative stroke as shown on graphs. Sheathing exhibited significant racking before it unzipped from the bottom plate (Photos 684, 699). No nail fatigue was observed. None of sheathing nails tore through the edge. Sheathing nails bent, pulled out of wood, or pulled heads through the sheathing (Photos 695-700). Sheathing moved relative to the studs and top plate up to 0.2 in. at failure as graphs show. The test was stopped at 3.3-in. amplitude when the wall separated from the bottom plate and load dropped to zero.

Instrumentation: Same instrumentation configuration was used as for wall 12IAc1. Sampling rate was 25 Hz.

Wall 12IAc2

Observations: This wall exhibited the lowest performance of the entire series. It reached peak load (4300 lbf.) at the negative 0.9-in. displacement. Load quickly dropped after 1.2-in. amplitude was exceeded. Failure mechanism was the same as with wall 12IAc1: Sheathing unzipped from the bottom plate. The test was stopped at 1.8-in. amplitude when the wall separated from the bottom plate entirely. No nail fatigue was observed. All sheathing nails tore through the edge at the bottom. The rest of the sheathing moved relative to the studs and top plate less than 0.15 in. as graphs show. Uplift displacement of studs was symmetrical until failure as shown on graphs. The possible reason for the low response of this wall might have been the lower density of the bottom plate – 400 kg/m^3. (The density of the bottom plate in 12IAm1 wall was 450 kg/m^3.)

Instrumentation: Sampling rate was 25 Hz. LVDT at Sheathing #3 channel was disconnected.

Wall 12IAc2r

Rationale: After the test of wall 12IAc2, the wall remained visually intact except for the bottom plate and unzipped sheathing at the bottom. The critical issue was the performance of sheathing-to-framing connections at the bottom plate. To estimate the performance of the same wall after repair, the bottom plate was replaced (density 475 kg/m^3) and sheathing nails were driven along the bottom at 6 in. o. c. with the edge distance of 3/4 in. (Similar situation was used during the tests of walls 08IAc)

The test was conducted 1 hour after the repair.

Observations: As expected, the elastic stiffness was less than during the first test (12IAc2) due to the loading history of the perimeter nails. The wall reached 20% higher peak load (5199 lbf.) at 1.2-in. amplitude. Nevertheless, it did not last long and degraded rapidly during the next phase of loading at 1.5-in. deflection. The sheathing unzipped at both ends of the bottom plate: Nails pulled heads through at the right end and tore through at the left end. No nail fatigue was observed. The test was stopped at the end of the 3.3-in. phase when the wall separated from the bottom plate.

Instrumentation: Same instrumentation configuration was used as for wall 12IAc2. Sampling rate was 25 Hz.

Table 12IAc1. Data summary.

Specimen	**12IAc1**	**Per unit length**	
Shear Bolts		**cyclic test**	
Wall length		**12.00ft.**	**3.657m**
Date: 7-31-1998 **Time:**	14:03		
EEEP Parameters	**units**	**initial**	**stabilized**
Peak unit load, v_{peak}	Kip/ft. KN/m	0.393 5.738	0.339 4.944
Drift at peak load, Δ_{peak}	in. mm	1.058 26.86	0.905 22.99
Yield unit load, v_{yield}	Kip/ft. KN/m	0.347 5.061	0.305 4.447
Drift at yield load, Δ_{yield}	in. mm	0.339 8.62	0.416 10.57
Proportional limit, $0.4v_{peak}$	Kip/ft. KN/m	0.157 2.295	0.136 1.978
Drift at prop. limit, $\Delta@0.4v_{peak}$	in. mm	0.154 3.91	0.185 4.70
Unit load at failure or $0.8v_{peak}$	Kip/ft. KN/m	0.315 4.591	0.271 3.955
Drift at failure, $\Delta_{failure}$	in. mm	1.457 37.00	1.272 32.32
Shear modulus, G $@0.4v_{peak}$	Kip/in. KN/mm	8.192 1.434	5.855 1.025
Work until failure per unit length	Kip·ft./ft. KN·m/m	0.284 1.265	0.342 1.520
Unit load, $v_{1/300}$ @ 0.32 in. (8.13 mm)	Kips/ft. KN/m	0.241 3.515	0.226 3.295
Unit load, $v_{1/200}$ @ 0.48 in.(12.19 mm)	Kips/ft. KN/m	0.296 4.314	0.269 3.918
Unit load, $v_{1/100}$ @ 0.96 in. (24.38 mm)	Kips/ft. KN/m	0.391 5.703	0.332 4.845
Unit load, $v_{1/60}$ @ 1.6 in. (40.64 mm)	Kips/ft. KN/m	0.239 3.491	0.106 1.547
EVDR $@v_{peak}$		0.162	0.135

SEAOSC parameters		**units**	**negative**	**positive**	**average**
Yield Limit State	v_{YLS}	Kips/ft. KN/m	-0.209 -3.050	0.222 3.246	0.216 3.148
	Δ_{YLS}	in. mm	-0.228 -5.80	0.299 7.59	0.264 6.70
	G'_{YLS}	Kip/in. KN/mm	7.317 1.281	5.955 1.043	6.545 1.146
Strength Limit State	v_{SLS}	Kips/ft. KN/m	-0.416 -6.074	0.370 5.402	0.393 5.738
	Δ_{SLS}	in. mm	-1.213 -30.81	0.902 22.92	1.058 26.86
	G'_{SLS}	Kip/in. KN/mm	2.745 0.481	3.282 0.575	2.974 0.521

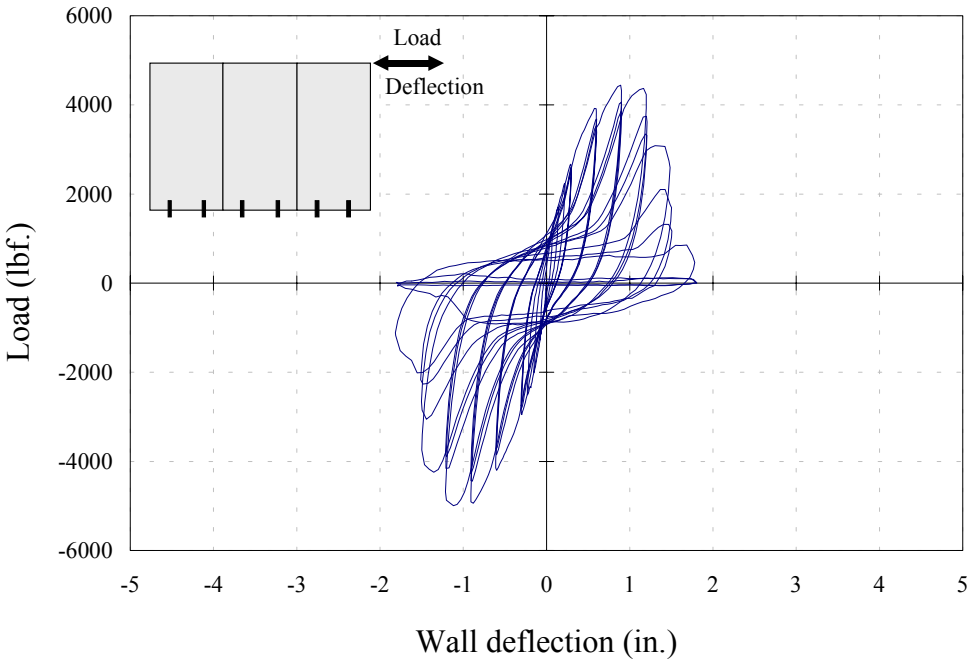


Figure 12IAc1- a. Observed load-deflection curve[1].

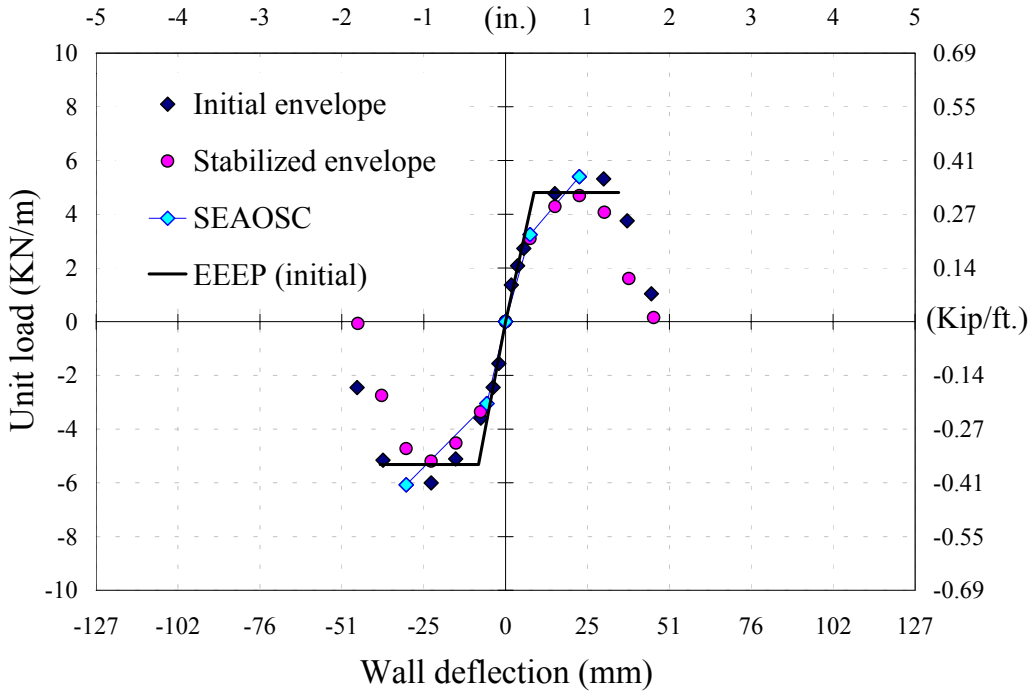


Figure 12IAc1- b. Envelopes, SEAOSC, and EEEP curves[2].

[1] The scale of the graph varies between test series.
[2] The scale of the graph is uniform between test series for comparison purposes.

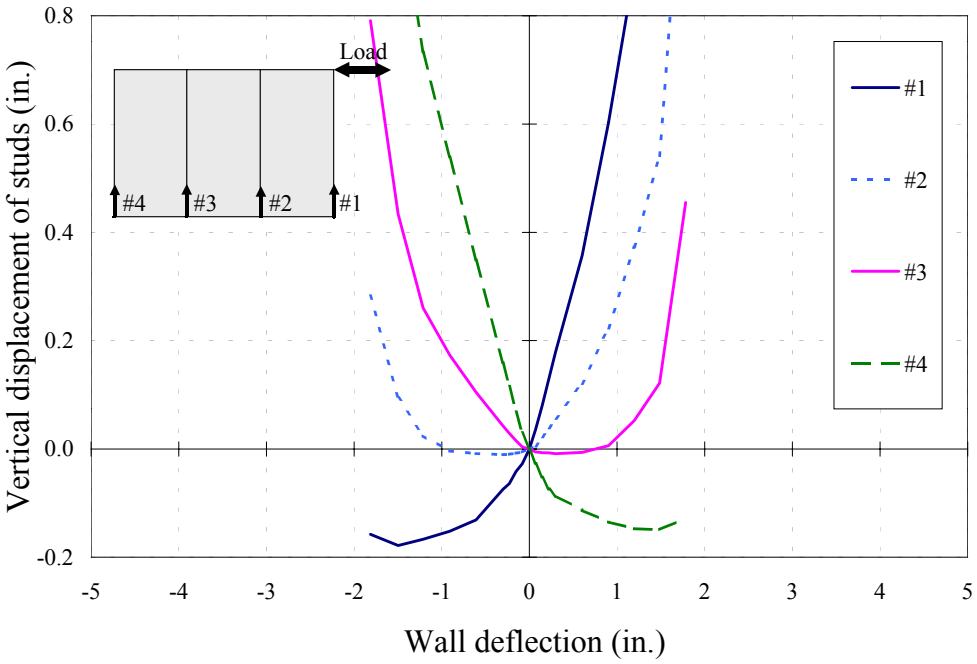


Figure 12IAc1- c. Vertical displacement of studs (initial envelope).

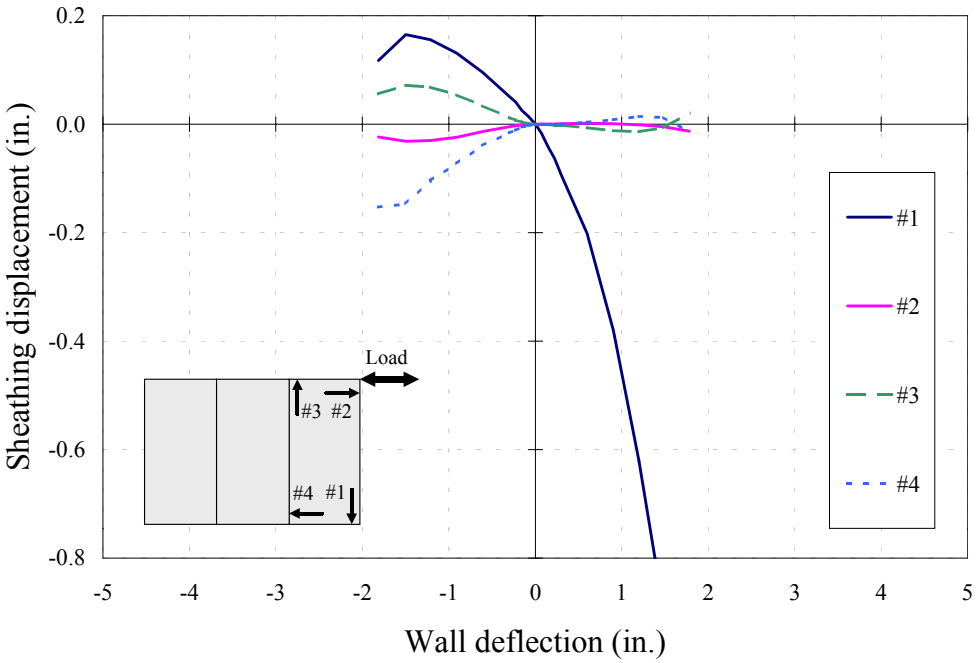


Figure 12IAc1- d. Sheathing displacement (initial envelope).

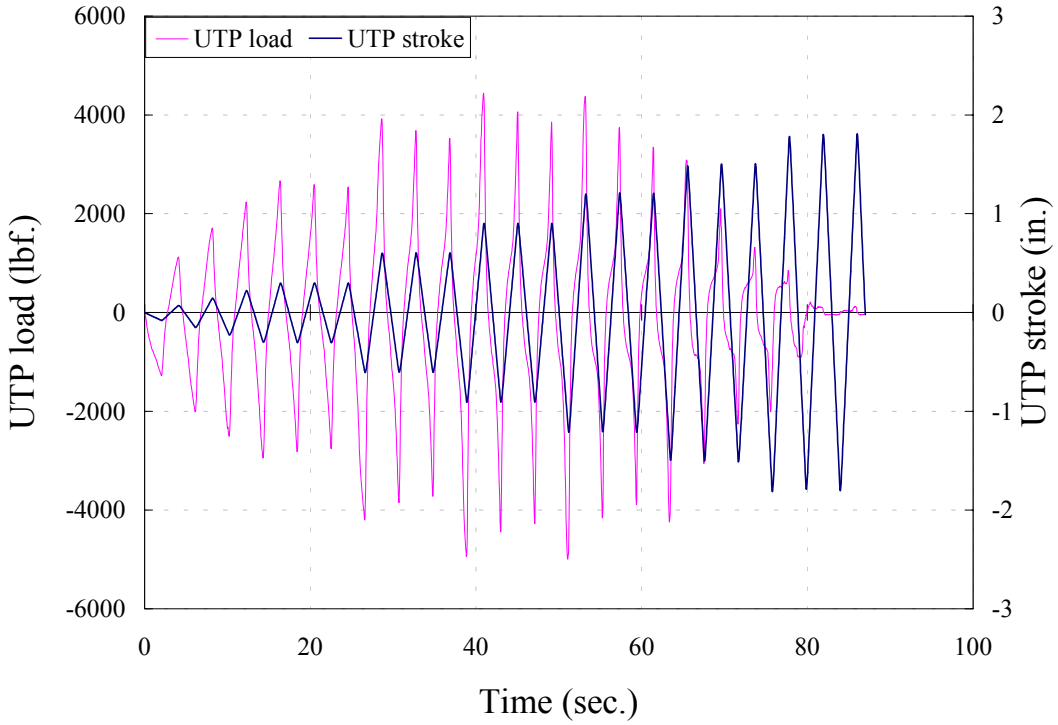


Figure 12IAc1- f. Load- and displacement-time record.

Table 12Iac1re. Data summary.

Specimen	**12IAc1re**	**Per unit length**	
Shear Bolts		**cyclic test**	
Wall length		**12.00ft.**	**3.657m**
Date: 8-01-1998. **Time:**	15:51		
EEEP Parameters	**units**	**initial**	**stabilized**
Peak unit load, v_{peak}	Kip/ft. KN/m	0.513 7.485	0.455 6.633
Drift at peak load, Δ_{peak}	in. mm	1.490 37.84	1.509 38.32
Yield unit load, v_{yield}	Kip/ft. KN/m	0.481 7.019	0.420 6.132
Drift at yield load, Δ_{yield}	in. mm	0.731 18.57	0.638 16.20
Proportional limit, $0.4v_{peak}$	Kip/ft. KN/m	0.205 2.994	0.182 2.653
Drift at prop. limit, $\Delta@0.4v_{peak}$	in. mm	0.312 7.92	0.276 7.01
Unit load at failure or $0.8v_{peak}$	Kip/ft. KN/m	0.410 5.988	0.364 5.307
Drift at failure, $\Delta_{failure}$	in. mm	2.561 65.06	2.372 60.26
Shear modulus, G $@0.4v_{peak}$	Kip/in. KN/mm	5.265 0.922	5.272 0.923
Work until failure per unit length	Kip·ft./ft. KN·m/m	0.965 4.291	0.896 3.987
Unit load, $v_{1/300}$ @ 0.32 in. (8.13 mm)	Kips/ft. KN/m	0.210 3.060	0.207 3.028
Unit load, $v_{1/200}$ @ 0.48 in.(12.19 mm)	Kips/ft. KN/m	0.298 4.344	0.286 4.176
Unit load, $v_{1/100}$ @ 0.96 in. (24.38 mm)	Kips/ft. KN/m	0.469 6.849	0.428 6.239
Unit load, $v_{1/60}$ @ 1.6 in. (40.64 mm)	Kips/ft. KN/m	**0.513** **7.484**	**0.450** **6.564**
EVDR $@v_{peak}$		0.128	0.111

SEAOSC parameters		**units**	**negative**	**positive**	**average**
Yield Limit State	v_{YLS}	Kips/ft. KN/m	-0.365 -5.323	0.203 2.965	0.284 4.144
	Δ_{YLS}	in. mm	-0.609 -15.48	0.299 7.59	0.454 11.53
	G'_{YLS}	Kip/in. KN/mm	4.788 0.839	5.440 0.953	5.003 0.876
Strength Limit State	v_{SLS}	Kips/ft. KN/m	-0.503 -7.348	0.522 7.616	0.513 7.482
	Δ_{SLS}	in. mm	-1.814 -46.06	1.781 45.25	1.797 45.65
	G'_{SLS}	Kip/in. KN/mm	2.221 0.389	2.344 0.410	2.282 0.400

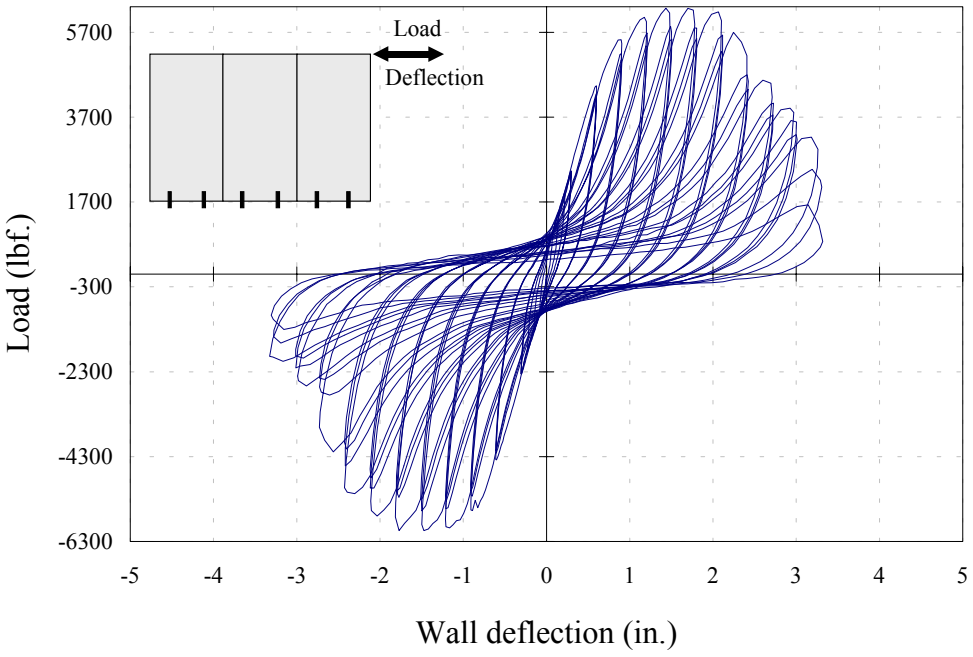


Figure 12IAc1re- a. Observed load-deflection curve.

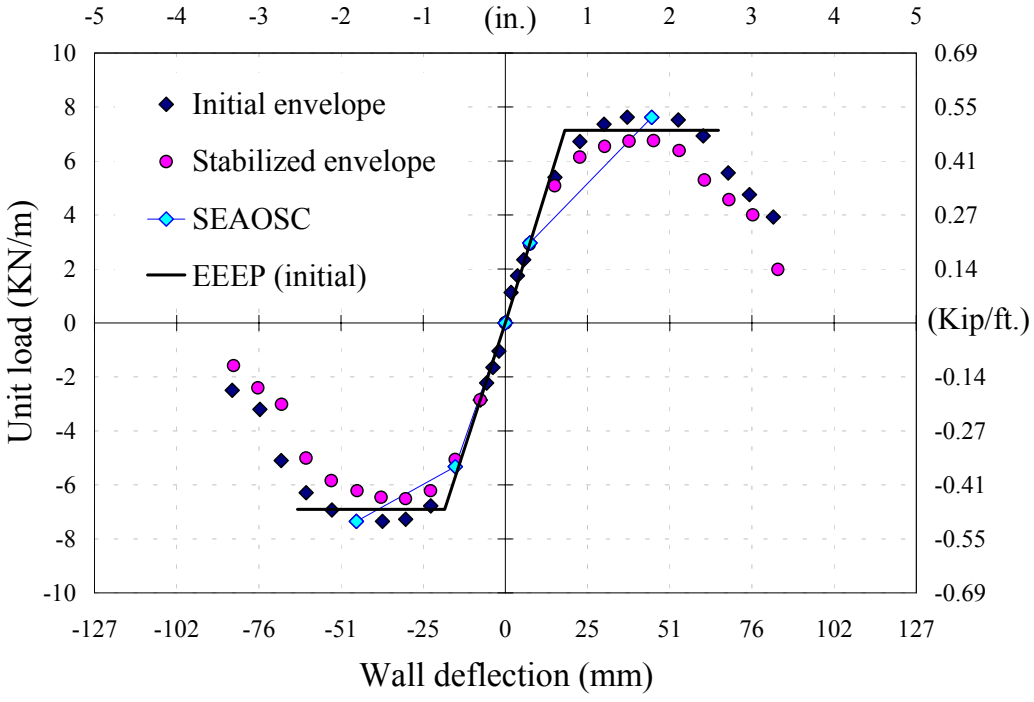


Figure 12IAc1re- b. Envelopes, SEAOSC, and EEEP curves.

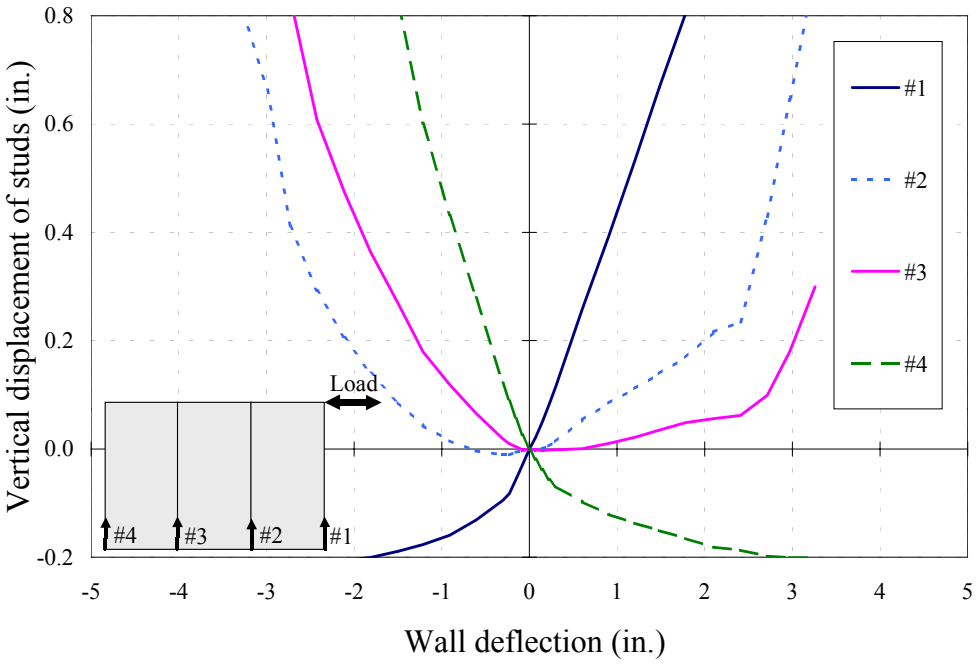


Figure 12IAc1re- c. Vertical displacement of studs (initial envelope).

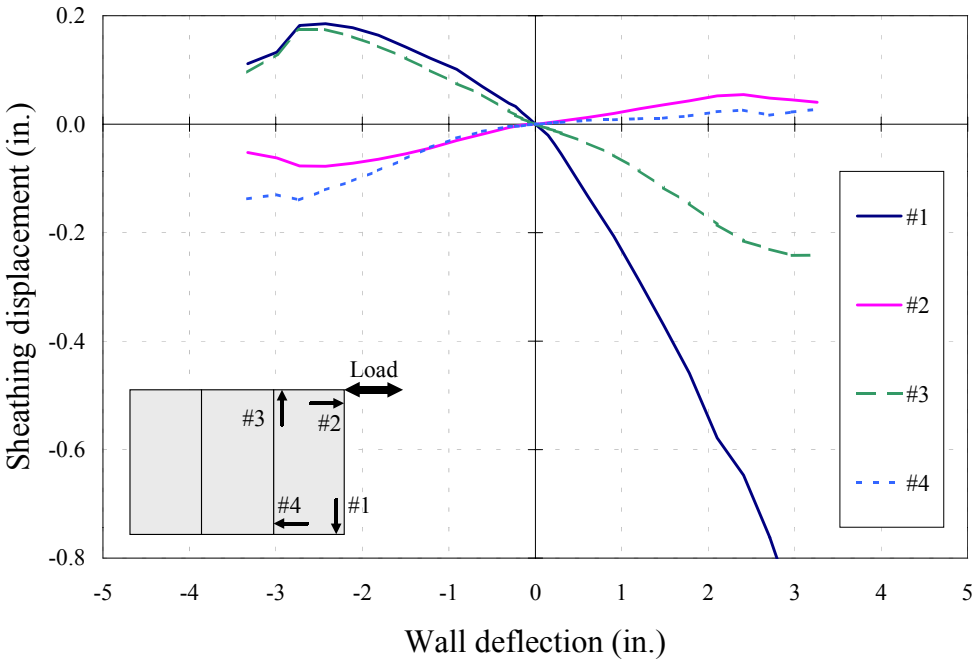


Figure 12IAc1re- d. Sheathing displacement (initial envelope).

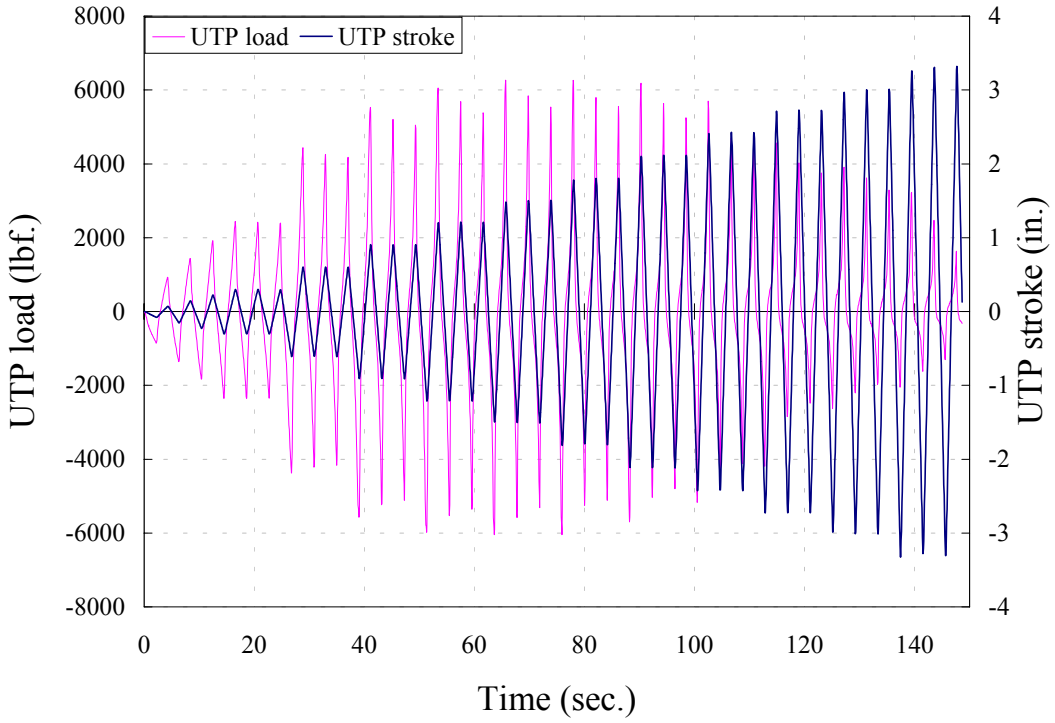


Figure 12IAc1re- f. Load- and displacement-time record.

Table 12IAc2. Data summary.

Specimen	**12IAc2**	**Per unit length**	
Shear Bolts		**cyclic test**	
Wall length		**12.00ft.**	**3.657m**
Date: 8-18-1998. **Time:**	17:18		
EEEP Parameters	**units**	**initial**	**stabilized**
Peak unit load, v_{peak}	Kip/ft. KN/m	0.343 5.002	0.280 4.092
Drift at peak load, Δ_{peak}	in. mm	0.908 23.07	0.757 19.24
Yield unit load, v_{yield}	Kip/ft. KN/m	0.303 4.419	0.260 3.793
Drift at yield load, Δ_{yield}	in. mm	0.290 7.38	0.374 9.50
Proportional limit, $0.4v_{peak}$	Kip/ft. KN/m	0.137 2.001	0.112 1.637
Drift at prop. limit, $\Delta@0.4v_{peak}$	in. mm	0.132 3.34	0.161 4.10
Unit load at failure or $0.8v_{peak}$	Kip/ft. KN/m	0.274 4.001	0.224 3.274
Drift at failure, $\Delta_{failure}$	in. mm	1.378 34.99	1.250 31.74
Shear modulus, G $@0.4v_{peak}$	Kip/in. KN/mm	8.336 1.460	5.561 0.974
Work until failure per unit length	Kip·ft./ft. KN·m/m	0.249 1.107	0.297 1.320
Unit load, $v_{1/300}$ @ 0.32 in. (8.13 mm)	Kips/ft. KN/m	0.229 3.336	0.214 3.125
Unit load, $v_{1/200}$ @ 0.48 in.(12.19 mm)	Kips/ft. KN/m	0.278 4.054	0.251 3.661
Unit load, $v_{1/100}$ @ 0.96 in. (24.38 mm)	Kips/ft. KN/m	0.339 4.945	0.113 1.648
Unit load, $v_{1/60}$ @ 1.6 in. (40.64 mm)	Kips/ft. KN/m	0.205 2.993	0.020 0.298
EVDR $@v_{peak}$		0.171	0.142

SEAOSC parameters		**units**	**negative**	**positive**	**average**
Yield Limit State	v_{YLS}	Kips/ft. KN/m	-0.203 -2.965	0.178 2.602	0.191 2.784
	Δ_{YLS}	in. mm	-0.228 -5.80	0.220 5.58	0.224 5.69
	G'_{YLS}	Kip/in. KN/mm	7.113 1.246	6.494 1.137	6.809 1.192
Strength Limit State	v_{SLS}	Kips/ft. KN/m	-0.358 -5.229	0.327 4.774	0.343 5.002
	Δ_{SLS}	in. mm	-0.911 -23.14	0.905 22.99	0.908 23.07
	G'_{SLS}	Kip/in. KN/mm	3.146 0.551	2.891 0.506	3.019 0.529

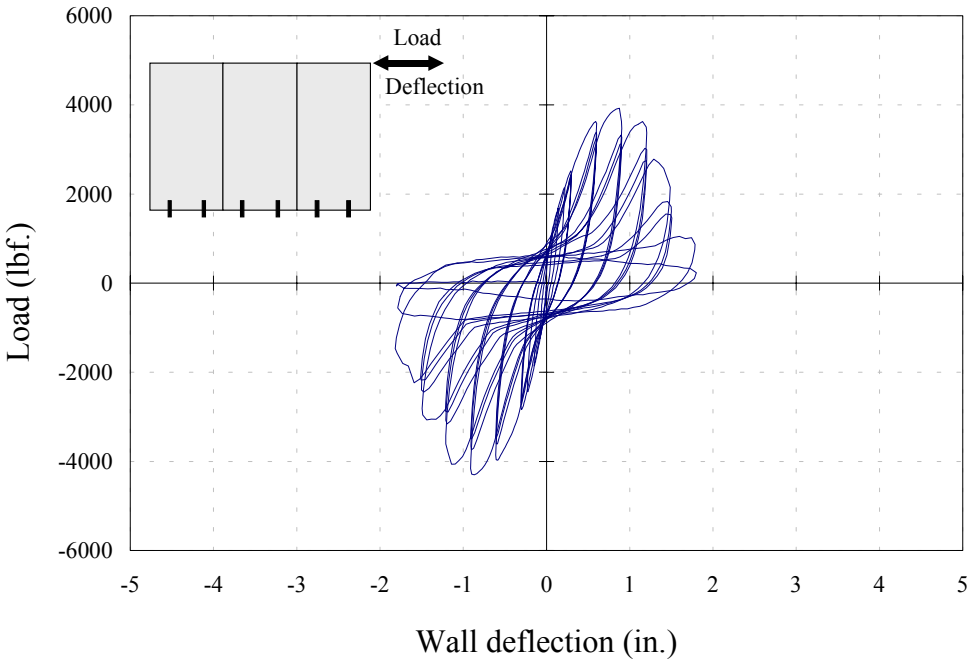


Figure 12IAc2- a. Observed load-deflection curve.

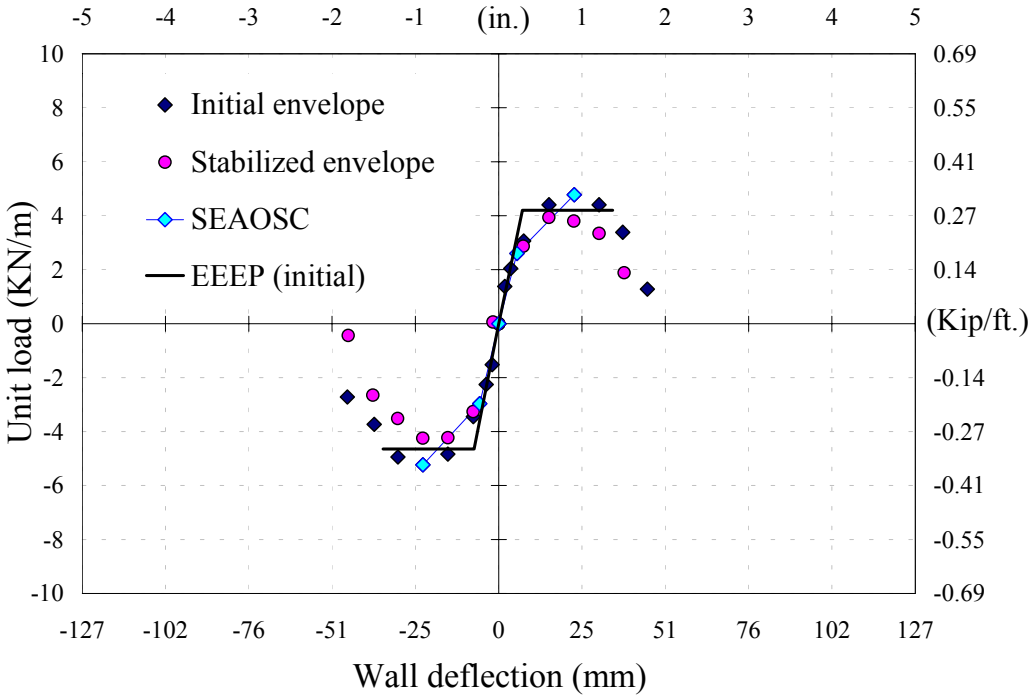


Figure 12IAc2- b. Envelopes, SEAOSC, and EEEP curves.

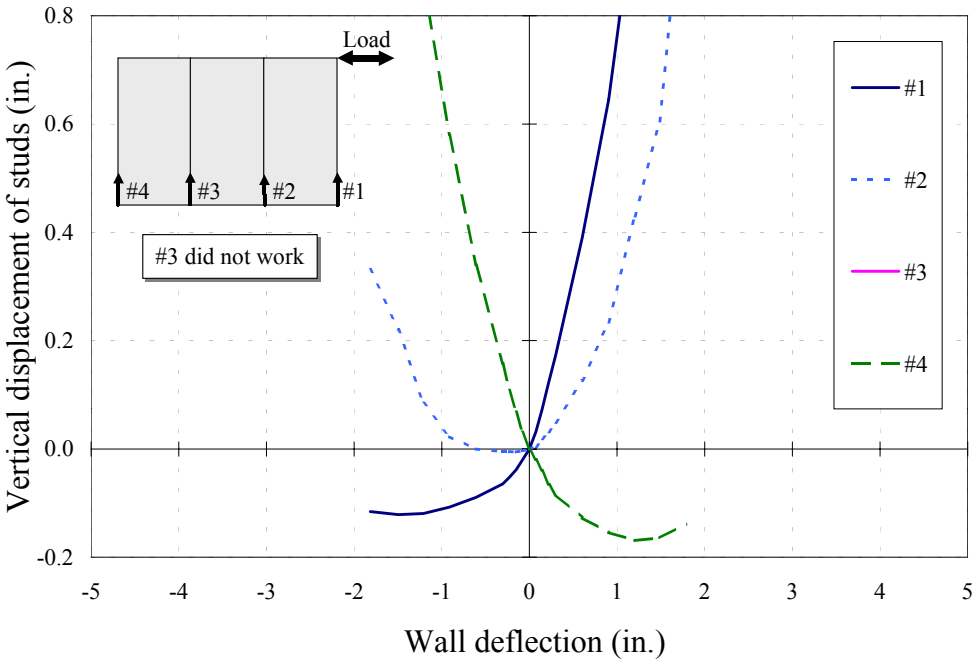


Figure 12IAc2- c. Vertical displacement of studs (initial envelope).

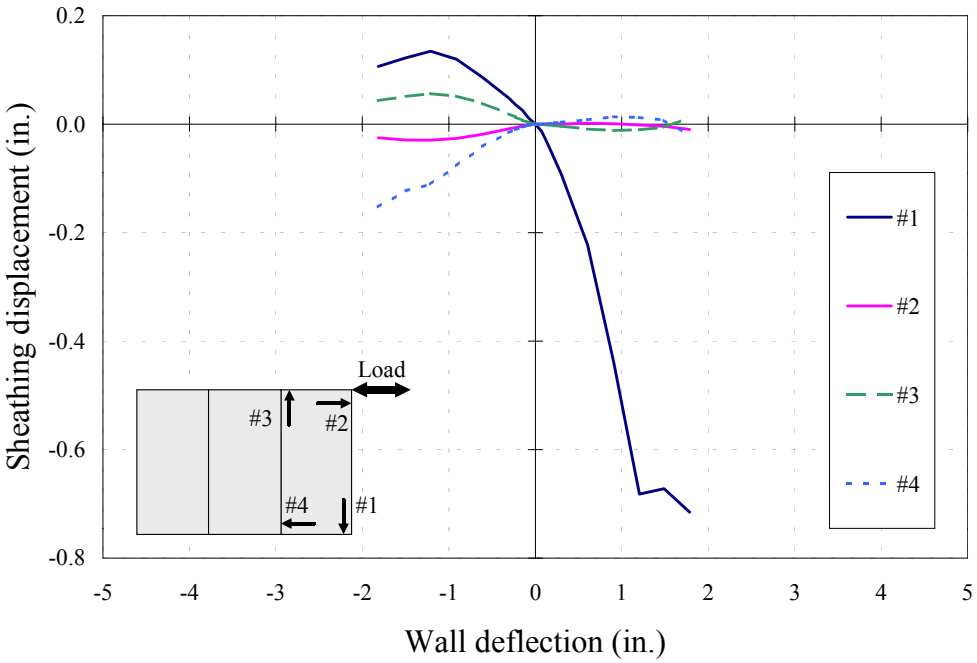


Figure 12IAc2- d. Sheathing displacement (initial envelope).

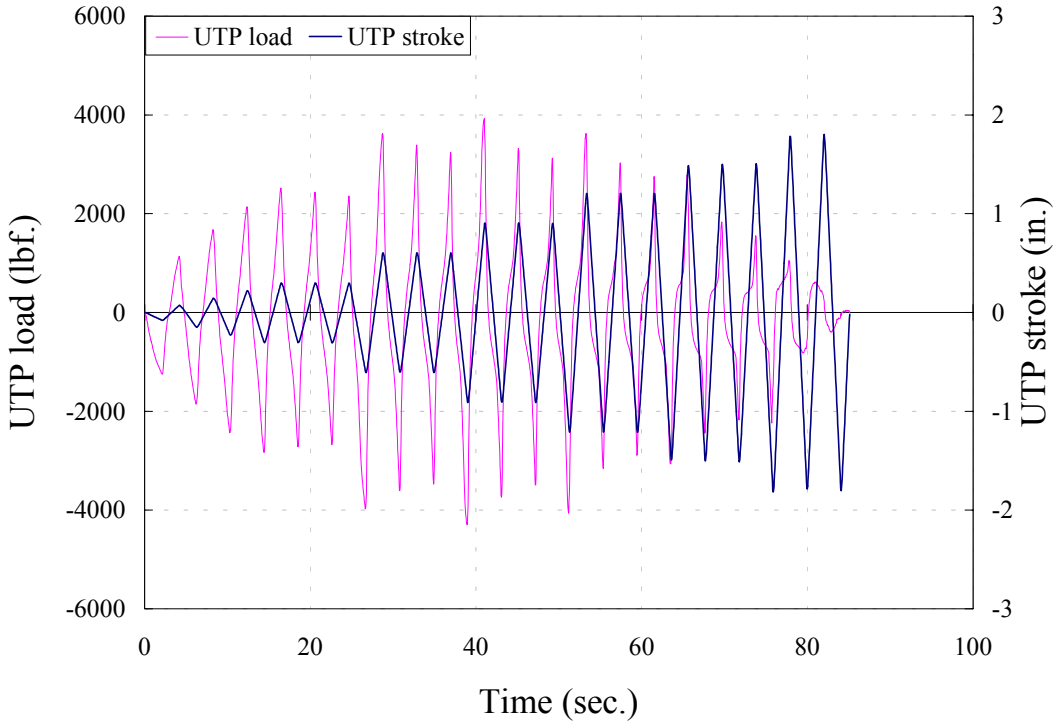


Figure 12IAc2- f. Load- and displacement-time record.

Table 12IAc2r. Data summary.

Specimen	**12IAc2r**	**Per unit length**	
Shear Bolts		**cyclic test**	
Wall length		**12.00ft.**	**3.657m**
Date: 8-19-1998. **Time:**	10:57		
EEEP Parameters	**units**	**initial**	**stabilized**
Peak unit load, v_{peak}	Kip/ft. KN/m	0.433 6.313	0.371 5.408
Drift at peak load, Δ_{peak}	in. mm	1.209 30.70	0.905 22.99
Yield unit load, v_{yield}	Kip/ft. KN/m	0.388 5.665	0.339 4.943
Drift at yield load, Δ_{yield}	in. mm	0.470 11.95	0.469 11.92
Proportional limit, $0.4v_{peak}$	Kip/ft. KN/m	0.173 2.525	0.148 2.163
Drift at prop. limit, $\Delta@0.4v_{peak}$	in. mm	0.210 5.33	0.205 5.22
Unit load at failure or $0.8v_{peak}$	Kip/ft. KN/m	0.346 5.050	0.296 4.326
Drift at failure, $\Delta_{failure}$	in. mm	1.586 40.28	1.427 36.25
Shear modulus, G $@0.4v_{peak}$	Kip/in. KN/mm	6.602 1.156	5.773 1.011
Work until failure per unit length	Kip·ft./ft. KN·m/m	0.403 1.793	0.362 1.610
Unit load, $v_{1/300}$ @ 0.32 in. (8.13 mm)	Kips/ft. KN/m	0.231 3.371	0.225 3.283
Unit load, $v_{1/200}$ @ 0.48 in.(12.19 mm)	Kips/ft. KN/m	0.303 4.420	0.284 4.146
Unit load, $v_{1/100}$ @ 0.96 in. (24.38 mm)	Kips/ft. KN/m	0.425 6.198	0.369 5.383
Unit load, $v_{1/60}$ @ 1.6 in. (40.64 mm)	Kips/ft. KN/m	0.335 4.893	0.227 3.316
EVDR $@v_{peak}$		0.155	0.130

SEAOSC parameters		**units**	**negative**	**positive**	**average**
Yield Limit State	v_{YLS}	Kips/ft. KN/m	-0.222 -3.243	0.222 3.240	0.222 3.242
	Δ_{YLS}	in. mm	-0.302 -7.67	0.299 7.59	0.300 7.63
	G'_{YLS}	Kip/in. KN/mm	5.891 1.032	5.944 1.041	5.917 1.036
Strength Limit State	v_{SLS}	Kips/ft. KN/m	-0.433 -6.322	0.432 6.303	0.433 6.313
	Δ_{SLS}	in. mm	-1.213 -30.81	1.204 30.58	1.209 30.70
	G'_{SLS}	Kip/in. KN/mm	2.858 0.500	2.870 0.503	2.864 0.501

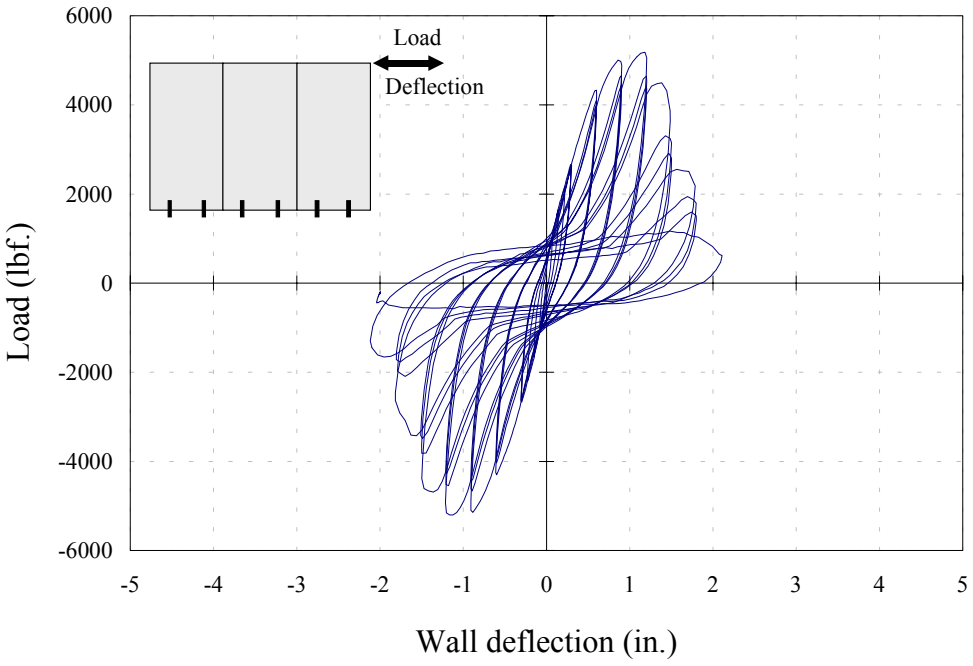


Figure 12IAc2r- a. Observed load-deflection curve.

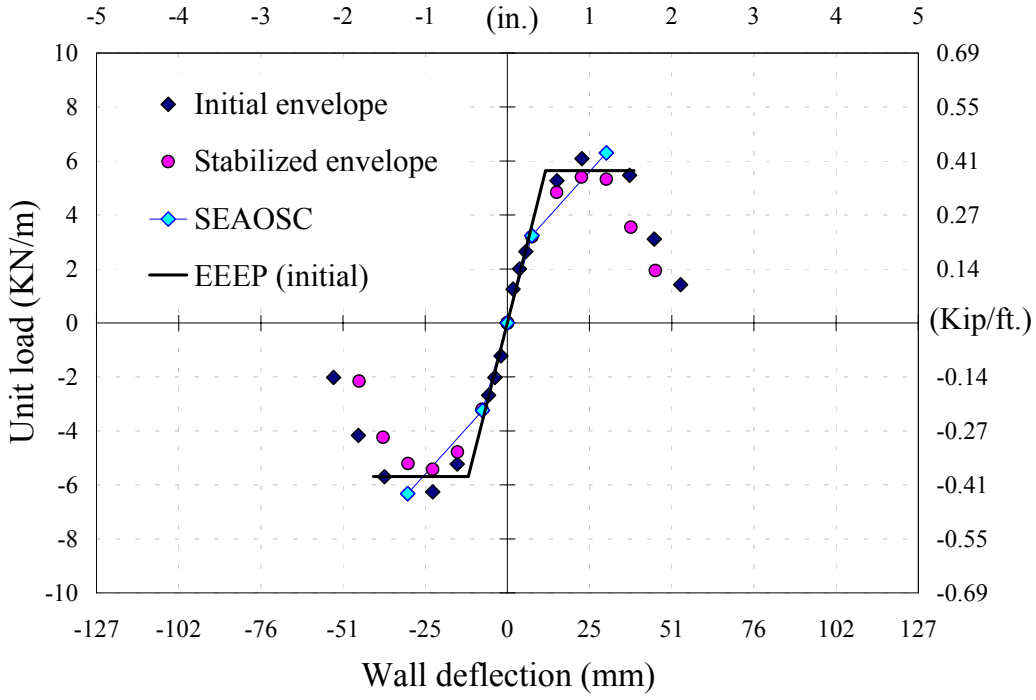


Figure 12IAc2r- b. Envelopes, SEAOSC, and EEEP curves.

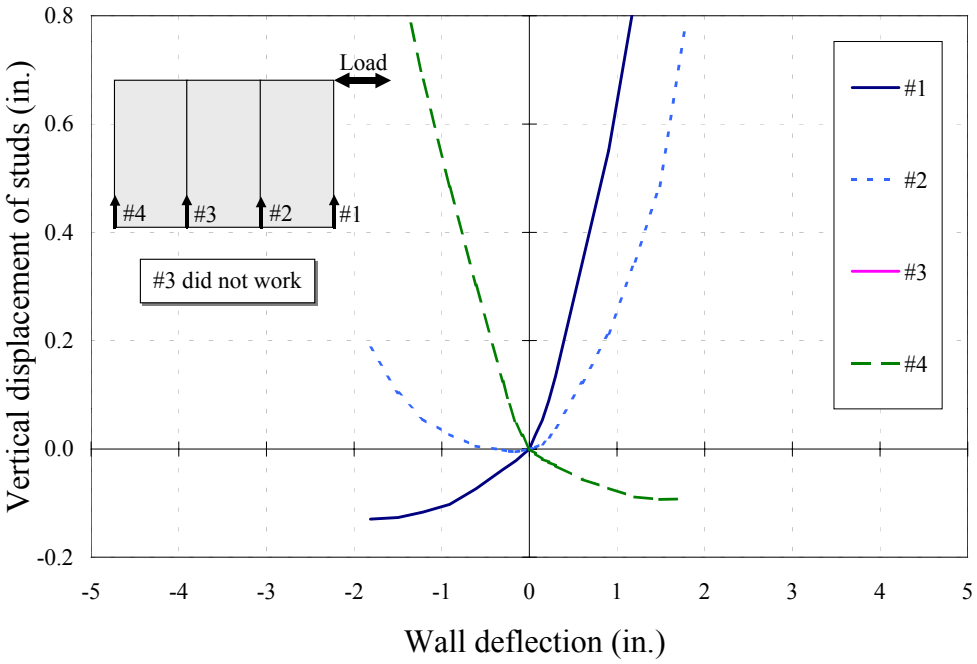


Figure 12IAc2r- c. Vertical displacement of studs (initial envelope).

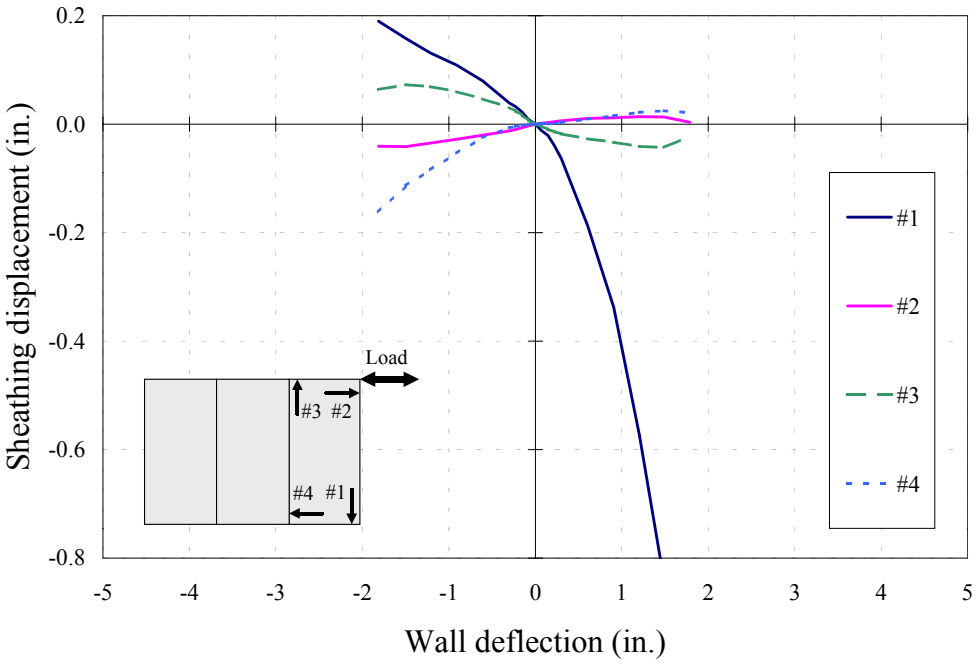


Figure 12IAc2r- d. Sheathing displacement (initial envelope).

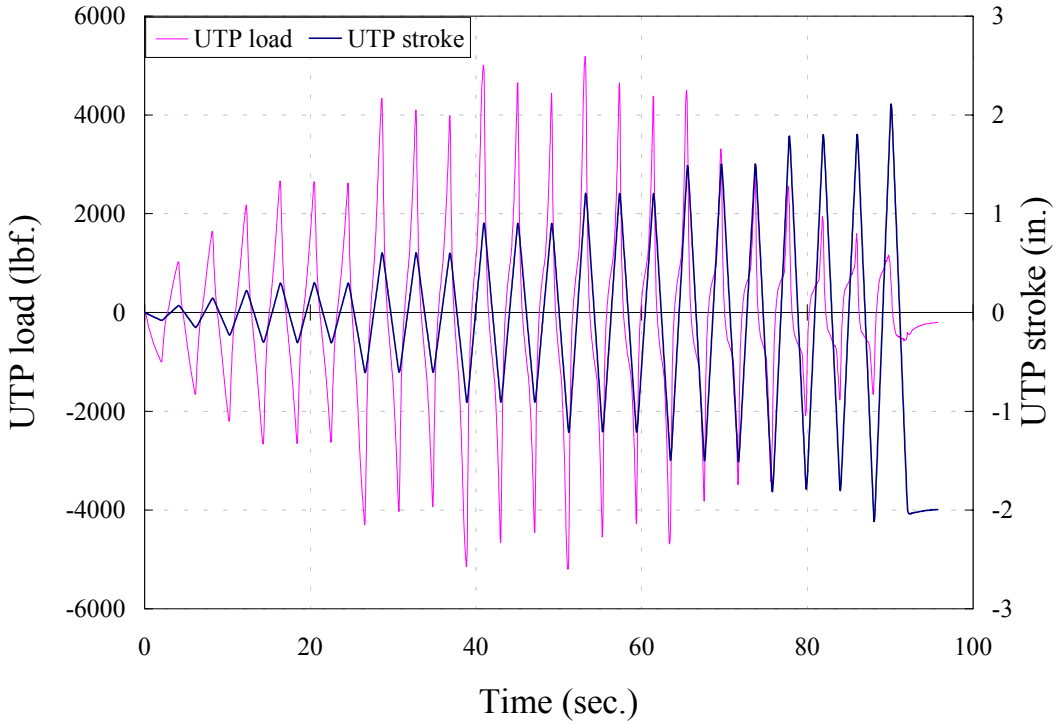


Figure 12IAc2r- f. Load- and displacement-time record.