Bracing Methods (see Table Notes)	Test Method / Restraint	Wall Assembly					Load-Deflection Data						Comments
		General (length, height, openings, etc)	Exterior Face / Bracing	Interior Face / Bracing	Wall Framing	Wall Plate Connections to Test Rig	Ultimate Load (lbs)	Drift at Ultimate (in)	Drift at _% of ultimate load	Drift at __% of ultimate load	Drift at __% of ultimate load	Energy Dissipated (kip-ft)	
Method 1	E72 (non-cyclic, full restraint)	8'x8'	1x4 let-in (45deg), Constr. Grade DF with 2-8d common nails at each stud and plate connection	½" GWB with 1-1/4" long GWB-54 nails at 8"oc all framing, edges and field (joints taped)	2x4 @ 24"oc, C&S Grade, WC Hemlock	? (probably bolted to 4x4 load and reaction beams)	4310 lbs (538 plf per 8-foot of wall with 45deg brace)	Need to get full report with L-D plots	0.24" (27%)	0.4" (56%)			(see ref#1, wall type 1) Originally permitted in MPS but not consistent with HUD Circular 12 performance criteria
Method 1	E72 (non-cyclic, full restraint)	8'x8'	1x4 let-in (45deg), No2 Spruce with 2-8d common nails at each stud and plate connection	½" GWB with 1-1/4" long GWB-54 nails at 8"oc all framing, edges and field (joints taped)	2x4 @ 24"oc, C&S Grade, WC Hemlock	? (probably bolted to 4x4 load and reaction beams)	3560 lbs (445 plf per 8-foot of wall with 45deg brace)	Need to get full report with L-D plots	0.15" (34%)	0.37" (67%)			(see ref#1, wall type 2) Permitted in MPS but not consistent with HUD Circular 12 performance criteria
Method 1	E72 (non-cyclic, full restraint)	8'x8'	1x4 let-in (45deg), No2 Spruce with 2-8d common nails at each stud and plate connection	½" GWB with 1-1/4" long GWB-54 nails at 8"oc all framing, edges and field (joints taped)	2x4@16"oc, C&S Grade, WC Hemlock	? (probably bolted to 4x4 load and reaction beams)	4920 lbs (615 plf per 8-foot of wall with 45deg brace)	Need to get full report with L-D plots	0.12" (24%)	0.26" (49%)			(see ref#1, wall type 3) Permitted in MPS but not consistent with HUD Circular 12 performance criteria
Method 1	E72 (non-cyclic, full restraint)	8'x8'	1x4 let in brace (45deg), "clear pine", 3-10d common nails to top and bottom plates, 2-10d common nails to each stud	1/.2" Gypsum wall board with 1-1/4" annular ring GWB nails at 8"/8" edge/field (joints taped); vertical install	Not reported (probably studs at 16"oc, species unknown, probably No1 SP)	3-bolts/each along top and bottom plate to "timber" load and reaction beams	4567 lbs (571 plf per 8-foot of wall with 45deg brace) COV = 3% (3 tests)	Plots or data with deflection at ultimate load not shown	0.12" (26%) COV=19%	0.3" (52%) COV=15%			(see ref#2, wall constr. #2) Compared with Method 5 one-side partition data from Ref#2 (see Method 5, Wall Constr #1 below), the let-in adds about 2,100 lbs of ult. shear resistance .when GWB nailed at 8"/8"
Method 1	E72 (non-cyclic, full restraint)	8'x8'	1x4 let in brace (45deg), "clear pine", 3-10d common nails to top and bottom plates, 2-10d common nails to each stud	1/.2" Gypsum wall board with 1-1/4" annular ring GWB nails at 8"/8" edge/field (joints taped); horiz. install	Not reported (probably studs at 16"oc, species unknown, probably No1 SP)	3-bolts/each along top and bottom plate to "timber" load and reaction beams	5067 lbs (633 plf per 8-foot of wall with 45deg brace) COV = 8% (3 tests)	Plots or data with deflection at ultimate load not shown	0.16" (24%) COV=10%	0.42" (47%) COV=2%			(see ref#2, wall constr. #9) – only difference from test above (wall constr #2) is GWB installed horizontally

Method 1	E72 (non-cyclic, full restraint)	8'x8'	1x4 let in brace (45deg), "clear pine", 3-10d common nails to top and bottom plates, 2-10d common nails to each stud	1/.2" Gypsum wall board with 1-1/4" annular ring GWB nails at 8"/8" edge/field (joints taped); horiz. install	Not reported (probably studs at 16"oc, species unknown, probably No1 SP)	3-bolts/each along top and bottom plate to "timber" load and reaction beams	5667 lbs (708 plf per 8-foot of wall with 45deg brace) COV=10%	Plots or data with deflection at ultimate load not shown	0.13" (21%) COV=15%	0.313" (42%) COV=19%			(see ref#2, wall constr. #4) – only difference from test above (wall constr #2) is GWB installed wih 4"oc edge nailing in lieu of 8"oc; relative to ref#2 wall constr. #3 below (Method 5, one-side, with GWB nailed 4"oc edges), the let-in brace adds 1,767 lbs ult. shear resistance.
Method 1 (1x4 brace alone)	E72 (non-cyclic, full restraint)	8'x8'	1x4 let in brace (45deg), various species as indicated, 2-8d common nails per stud/plate	None	2x4@16"oc, DF No2&Btr	Typical for E72	3,183 lbs (avg) 2,900 lbs (White pine) 4,450 lbs (SP) 3,550 lbs (SP) 2,350 lbs (Sugar Pine) 2,850 lbs (Sugar Pine) 3,000 lbs (Sugar Pine)	Not reported	0.5" (30%) Estimated from one representative plot				(See Ref #7, Table 3) Note that these braces were all tested in compression direction, 3 of 6 braces failed with compression brace failure; one test was conducted with brace in tension and failed at 1,900 lbs; tests with horiz. board sheathing on brace side and on opposite side failed at 6,050 lbs and 5,450 lbs, respectively.
Method 1 (1x4 brace alone)	E564 (non-cyclic, end stud fully restrained, but not top plate, so essentially no restraint provided)	8'x8'	1x4 let in brace (45 deg) No 2 SPF with 2-8d common nails per stud and plate connections; brace tested in tension or compression as indicated	None	2x4@24"oc SPF Const Gr, 16d common framing nails, single end stud and single top and bottom plate (OVE framing)	Typical for E72 (4x4 wood load beam with two bolts from plate to beam)	Compression: 600 lbs Tension: 567 lbs	Not reported	Compression: 0.1" (42%) Tension: 0.1" (35%)	Compression: 0.2" (58%) Tension: 0.2" (47%)	Compression: 0.5" (75%) Tension: 0.5" (65%)		(see Ref #8, Table 2) Values are averages of 2 compression tests and 3 tension tests (COV wsa 10% or less) Failure mode for compression tests were separation of the top plate at first stud and separation of stud from bottom plate at 2nd stud (O.T. restraint was provided by plate nails in end grain of studs only). Failure mode for tension test was nail slip (shear) from brace to stud or plate (see Method 1 + GWB tests and GWB only (method 5) tests per Ref #8 for comparison)

Method 1 (metal strap alone)	E564 (non-cyclic, end stud fully restrained, but not top plate, so essentially no restraint provided)	8'x8'	2" wide metal strap (HUD approved), gauge not reported, 2-8d common nails per stud and to top and bottom wide face of plates, tested in tension	None	2x4@24"oc SPF Const Gr, 16d common framing nails, single end stud and single top and bottom plate (OVE framing)	Typical for E72 (4x4 wood load beam with two bolts from plate to beam)	1467 lbs (COV=10%)	Not reported	0.1" (39%)	0.2" (57%)	0.5" (82%)		(see Ref #8, Table 2) Failure was nail shear at strap to stud or plate connection Data is average of 3 tests.
Method 1 (1x4 with GWB)	E564 (non-cyclic, end stud fully restrained, but not top plate, so restraint provided only be GWB and end nails in studs)	8'x8'	1x4 let in brace (45 deg) No 2 SPF with 2-8d common nails per stud and plate connections; brace tested in tension or compression as indicated	½" GWB (vertical) with 1-1/4" GWB nails at 8"oc along all members, taped and spackled center joint	2x4@24"oc SPF Const Gr, 16d common framing nails, single end stud and single top and bottom plate (OVE framing)	Typical for E72 (4x4 wood load beam with two bolts from plate to beam)	Compression: 1825 lbs (COV=5%) Tension: 1633 lbs (COV=9%)	~0.7" (100%)	Compression: 0.1" (47%) Tension: 0.1" (53%)	Compression: 0.2" (64%) Tension: 0.2" (71%)	Compression: 0.5" (92%) Tension: 0.5" (92%)		(see Ref #8, Table 2) 4 tests in compression and 3 tests in tension loading of brace 1167 lbs was attained with GWB alone (see Ref #8 Method 5 below); 567 lbs to 600 lbs was attained with 1x4 let-in brace alone.
Method 1 (metal strap with GWB)	E564 (non-cyclic, end stud fully restrained, but not top plate, so restraint provided only be GWB and end nails in studs)	8'x8'	2" wide metal strap (HUD approved), gauge not reported, 2-8d common nails per stud and to top and bottom wide face of plates, tested in tension	½" GWB (vertical) with 1-1/4" GWB nails at 8"oc along all members, taped and spackled center joint	2x4@24"oc SPF Const Gr, 16d common framing nails, single end stud and single top and bottom plate (OVE framing)	Typical for E72 (4x4 wood load beam with two bolts from plate to beam)	2425 lbs (COV=4%)	Not reported	0.1" (41%)	0.2" (67%)	0.5" (95%)		(see Ref #8, Table 2) 4 tests in tension only
Method 1 (2-1x4 let-ins with horiz board sheathing)	Similar to E72 (non-cyclic, fully restrained)	9'x14'	8" horiz. board sheathing with 2-8d common per stud and two 1x4 let-in braces at 63deg angle, nails in let-ins were not reported	None	2x4@16"oc, 16d common framing nails, all framing and sheathing was No1 common SYP	Similar to E-72 with wall plates bolted to top an bottom wood beams	9,250 lbs	Not reported					(see Ref #10, Table 1) Horizontal board sheathing without let in braces gave about 2,588 lbs resistance for 9x14 and 7.3'x12' walls (roughly 200 plf); this suggest let-in braces added 3,206 lbs/brace to the wall resistance – this is similar to the E72 tests of let-in brace only as reported above (Ref #7)

Method 1 (2 – 1x4 let-ins with horiz. board sheathing)	Similar to E72 (non-cyclic, fully restrained)	8'x12'	8" horiz. board sheathing , SYP No1 Sheathing Grade with 2-8d common per stud	two 1x4 let-in braces at 45deg angle, nails in let-ins were not reported	2x4@16"oc and 24"oc (as indicated), 16d common framing nails, all framing No 1 Doug fir	Similar to E-72 with wall plates bolted to top an bottom wood beams	16"oc frame: 7,776 lbs 24"oc frame: 3,972 lbs	1.1 to 2.9" (100%)	0.1" (15%) 0.2" (30%)	0.3" (35%) 0.5" (68%)			(see Ref. #12, Table 1) Compression brace was full length, brace on other end of wall was in K configuration.
Method 2 (diagonal board sheathing)	Similar to E72 (non-cyclic, fully restrained)	9'x14'	8" diag.. board sheathing with 2-8d common per stud/plate	None	2x4@16"oc, 16d common framing nails, all framing and sheathing was No1 common SYP	Similar to E-72 with wall plates bolted to top an bottom wood beams	20,100 lbs (1,435 plf)	Not reported					(see Ref #10, Table 1)
Method 3 (one 4x8 WSP on 8'x8' wall)	E72 (non-cyclic, full restraint)	8'x8'	One 4'x8'x1/2" plywood sheathing grade, 7d common nails (0.131"x2-1/2") at 6"/12" edge/field	1/.2" Gypsum wall board with 1-1/4" annular ring GWB nails at 8"/8" edge/field (joints taped); vertical install	Not reported (probably studs at 16"oc, species unknown, maybe No1 SP)	3-bolts/each along top and bottom plate to "timber" load and reaction beams	4033 lbs (504 plf per 8-foot of wall with 4-foot brace panel) COV=3%	Plots or data with deflection at ultimate load not shown	0.13" (30%) COV=15%	0.35" (59%) COV=19%			(see ref#2, wall constr. #9) – only difference from wall constr #2 was use of 4-foot Method 3 brace instead of 1x4 let-in; Relative to wall construction #1 (Method 5, one-side partition), the Method 3 panel adds 1,566 lbs of ult. Shear resistance. Considering only the section of wall with the Method 3 brace plus GWB the ult. unit shear is 758 plf or 3,032 lbs per Method 3 brace.
Method 3	E564 (non-cyclic, full restraint)	4'x8'	7/16" OSB PS-2 with 8d common nails (0.131"x2.5") at 6"/12" edge/field (nails located at ¾" from sheathing edges)	None	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	2510 lbs (628 plf)	3.84" (at 100% peak load)	0.5" (48%)	5.6" (failure at 80% peak load after peak reached)		0.97 k-ft (energy under curve)	(see Ref #5, Table 7)

Method 3 (plus GWB)	E564 (non-cyclic, full restraint)	4'x8'	7/16" OSB PS-2 with 8d common nails (0.131"x2.5") at 6"/12" edge/field (nails located at ¾" from sheathing edges)	½" GWB ASTM C36 with 11ga galv. roofing nail (0.120"x1.5" x 3/8" head) at 7"/16" edge/field	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	3040 lbs (760 plf)	3.23" (peak)	0.5" (59%)	5.1" (failure at 80% peak load after peak reached)		1.1 k-ft (energy under curve)	(see Ref#5, Table 7)
Method 3	E2126 (cyclic, full restraint) SPD hysteresis used, not CUREe	4'x8'	7/16" OSB PS-2 with 8d common nails (0.131"x2.5") at 6"/12" edge/field (nails located at ¾" from sheathing edges)	None	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	2210 lbs (553 plf)	2.98" (100%)	0.5" (56%)	4.58" (80% post peak)		7.8 k-ft	(see Ref #5, Table 10) Data reported here based on average of pos-neg initial cycle backbone curve
Method 3 (plus GWB)	E2126 (cyclic, full restraint) SPD hysteresis used, not CUREe	4'x8'	7/16" OSB PS-2 with 8d common nails (0.131"x2.5") at 6"/12" edge/field (nails located at ¾" from sheathing edges)	½" GWB ASTM C36 with 11ga galv. roofing nail (0.120"x1.5" x 3/8" head) at 7"/16" edge/field	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	2770 lbs (693 plf)	2.09" (100%)	0.5" (67%)	4.07" (80% post peak)		9.16 k-ft	(see Ref #5, Table 10) Data reported here based on average of pos-neg initial cycle backbone curve

Method 3	E2126 (cyclic, no restraint) SPD hysteresis used, not CUREe	4'x8'	7/16" OSB PS-2 with 8d common nails (0.131"x2.5") at 6"/12" edge/field (nails located at ¾" from sheathing edges)	None	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	700 lbs (175 plf)	1.82" (100%)	0.5" (64%)	3.28" (80% post-peak)		2.32 k-ft	(see Ref #5, Table 12) Data reported here based on average of pos-neg initial cycle backbone curve
Method 3 (plus GWB)	E2126 (cyclic, no restraint) SPD hysteresis used, not CUREe	4'x8'	7/16" OSB PS-2 with 8d common nails (0.131"x2.5") at 6"/12" edge/field (nails located at ¾" from sheathing edges)	½" GWB ASTM C36 with 11ga galv. roofing nail (0.120"x1.5" x 3/8" head) at 7"/16" edge/field	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	770 lbs (193 plf)	1.85" (100%	0.5" (71%)	2.65" (80% post-peak)		1.28 k-ft	(see Ref #5, Table 12) Data reported here based on average of pos-neg initial cycle backbone curve
Method 3	E72 (?) (non-cyclic, fully restrained)	8'x8'	5/16" plywood sheathing, DF with 6d common nails at 6"/12" edge/field	None	2x4@16"oc, Constr. Grade	Not reported.	7,300 lbs (913 plf)	Not reported	0.1" (15%)				(see Ref #6, Table 4-3) Data is from Adams, N.R., Plywood Shear Walls, APA Report 105, undated.
Method 3	E72 (?) (non-cyclic, fully restrained)	8'x8'	5/16" plywood sheathing, group 4 with 6d common nails at 6"/12" edge/field	None	2x4@16"oc, Constr. Grade	Not reported.	5,900 lbs (734 plf)	Not reported	0.1" (17%)				(see Ref #6, Table 4-3) Data is from Adams, N.R., Plywood Shear Walls, APA Report 105, undated.
Method 3	E72 (?) (non-cyclic, fully restrained)	8'x8'	5/16" plywood sheathing (horiz), group 4, with 6d common nails at 6"/12" edge/field	None	2x4@16"oc, Constr. Grade	Not reported.	5,100 lbs (638 plf)	Not reported	0.1" (18%)				(see Ref #6, Table 4-3) Data is from Adams, N.R., Plywood Shear Walls, APA Report 105, undated.

Method 3 (1/2" OSB, Flakeboard)	E72 (non-cyclic, fully restrained)	8'x8'	1/2" flakeboard, mixed species, density varying from 43 to 46 pcf, 8d common nails at 6"/12" edge/field with 3/8" edge distance at center joint and ¾" at perimeter	None	2x4@16"oc No1 SYP	Typical E72 set-up (wood beam, 2 bolts to plates, etc.)	5025 lbs (628 plf)	Not reported	0.1" (32%)				(see Ref #9, Table 1) 5/8" thick product also tested with density of 43 to 49 pcf and max load was about 500 lbs (62 plf) greater on average. Failure mode was sheathing nail yield and withdrawal
Method 3 (1/2" Plywood)	E72 (non-cyclic, fully restrained)	8'x8'	½" Plywood SP, CDX 3-ply, 8d-common nails at 6"/12" edge/field with 3/8" edge distance at center joint and ¾" at perimeter	None	2x4@16"oc No1 SYP	Typical E72 set-up (wood beam, 2 bolts to plates, etc.)	5980 lbs (748 plf)	Not reported	0.13" (27%)				(see Ref #9, Table 1) 5/8" 4-ply plywood was also tested but only gave 50 lbs (6 plf) additional max load. Failure mode was sheathing nail yield and withdrawal
Method 3 (1/4" plywood)	Similar to E72 (non-cyclic, fully restrained	8'x12'	¼" plywood, DF, exterior grade with 6d common nails at 5"/10" oc edges/field	None	2x4@16"oc and 24"oc (as indicated), 16d common framing nails, all framing No 1 Doug fir	Similar to E-72 with wall plates bolted to top an bottom wood beams	16"oc frame: 8904 lbs (742 plf) 24"oc frame: 8544 lbs (712 plf)	1.2 to 2.2" (100%)	0.06" (13%) 0.05" (14%)	0.14" (30%) 0.14" (32%)			(see Ref #12, Table 1)
Method 3 (15/32" plywood 3"/6" nailing)	E72 (non-cyclic, fully restrained)	8'x8'	15/32" APA 32/16 Exp 1, Plywood with 8d common nails at 3"/12"oc edges/field	None	2x4@16"oc West Hem	Typical E72, steel load beam, bolted bottom plate with steel plate washers	13,440 lbs (1,680 plf)	0.48" (51%)	0.96" (68%)				(see Ref #13, Table 2)
Method 3 (15/32" plywood 3"/6" nailing plus GWB)	E72 (non-cyclic, fully restrained)	8'x8'	15/32" APA 32/16 Exp 1, Plywood with 8d common nails at 3"/12"oc edges/field	½" GWB with 5d cooler (0.092" x 1-5/8") nails at 7"/7" oc edges/field (horiz. unblocked)	2x4@16"oc West Hem	Typical E72, steel load beam, bolted bottom plate with steel plate washers	16,310 lbs (2,039 plf)	0.48" (71%)	0.96" (81%)				(see Ref #13, Table 2) GWB alone in separate test was 2,030 lbs (254 plf) ultimate. Therefore, appears additive with tests of plywood alone (see above).

Method 3 (7/16” OSB with 4”/6” nailing as indicated)	E2126 with CUREe hysteresis	8’x8’	7/16” OSB APA 24/16 Exp 1 (vertical) nailed at 4”/6” with indicated fastener	None	2x4@24”oc No2 Doug-fir (3x4 used at center stud at vertical panel joint)	E2126 typical rigging	8d common 7491 lbs (936 plf) 8d galv box 7794 lbs (974 plf) 8d box 8331 lbs (1041 plf)	1.96” (100 %) 2.26 (100%) 2.67 (100%)					(see Ref #14) Note that nails all give similar peak values. The 8d box nail is reported to give about a 10% lower initial stiffness compared to 8d common ,but larger ductility and energy dissapation. Expected differences in strength based on nail diameter are predicted and seen with single fastener tests, but not in the shear wall tests. Other reports cited with similar results.
Method 3 (7/16”OSB, and 15/32” plywood + GWB, long walls)	E564 (non—cyclic, varying degrees of restraint as indicated)	8’x40’ (no openings)	7/16” OSB or 15/32” plywood (as indicated) each with 8d common nails at 6”/12” oc edge/field	½” GWB installed vertical, joints taped with 13g x 1-1/2”x3/8” head nails at 7”/10” oc edges/field	2x4@16”oc, SPF Stud, 16d common framing nails	E564 3x5 steel tube load beam, 5/8” anchor bolts with 3x3x1/4” plate washers at at 24”oc, Simpson HTT 22 hold-down for end stud anchorage with restrained tests only	7/16” OSB (no restraint): 25,100 lbs (628 plf) 7/16” OSB (full restraint) 34,600 lbs (865 plf) 15/32” Ply (full restraint) 38,600 lbs (965 plf)	1.2” (100%) 1.6” (100%) 2.3” (100%)	0.32” (56%) 0.32” (57%) 0.32” (49%)	0.96” (95%) 0.96” (92%) 0.96” (87%)			(see Ref #15) These tests also included perforated shear wall tests of walls with openings, but are not addressed here in terms of wall assembly basic unit shear values for varying conditions of restraint, etc. (see related Ref #16 and #17)
Method 3 (7/16”OSB and 15/32” plywood + GWB, long walls)	Similar to E2126 (cyclic, varying degrees of restraint as indicated) SPD hysteresis,	8’x40’ (no openings)	7/16” OSB or 15/32” plywood (as indicated) each with 8d common nails at 6”/12” oc edge/field	½” GWB installed vertical, joints taped with 13g x 1-1/2”x3/8” head nails at 7”/10” oc edges/field	2x4@16”oc, SPF Stud, 16d common framing nails	E564 3x5 steel tube load beam, 5/8” anchor bolts with 3x3x1/4” plate washers at at 24”oc, Simpson HTT 22 hold-down for end stud anchorage with restrained tests only	7/16” OSB (no restraint): 26,700 lbs (668 plf) 7/16” OSB (full restraint) 27,700 lbs (693 plf) 15/32” Ply (full restraint) 32,000 lbs (800 plf)	See hysteresis plots in report, peak load deflection not tabulated	0.32” (62%) 0.32” (61%) 0.32” (62%)	0.96” (99%) 0.96” (97%) 0.96” (99%)			(see Ref #16) Also see monotonic tests of same wall configurations in Ref #15 Also see cyclic tests of same wall construction with corner restraints per Ref #17. Data reported here is based on initial cycles of SPD hysteresis

Method 3 (7/16" OSB + GWB w/ corner restraint)	Similar to E2126 (cyclic, partial restraint by 2' and 4' wall corners as indicated	8'x12' with 2' or 4' corner returns (as indicated) at both ends of wall to	7/16" OSB or 15/32" plywood (as indicated) each with 8d common nails at 6"/12" oc edge/field	½" GWB installed vertical, joints taped with 13g x 1-1/2"x3/8" head nails at 7"/10" oc edges/field	2x4@16"oc, SPF Stud, 16d common framing nails	E564 3x5 steel tube load beam, 5/8" anchor bolts with 3x3x1/4" plate washers at at 24"oc, Simpson HTT 22 hold-down for end stud anchorage with restrained tests only	2-ft Corners: 7600 lbs (634 plf) 4-ft Corners: 8,500 lbs (708 plf)	See report for data	0.32" (82%) 0.32" (79%)	0.96" (93%) 0.96" (98%)		(Ref #17) IRC TABLE R602.10.1 -- 634 plf with safety factor of 2 was used as design value for application of perforated shear wall equation F=r/(2-r) to determine Method 3 and R602.10.5 bracing amounts based on 100%, 85%, and 67% opening heights in walls. Thus, IRC requires the equivalent of a 2-foot corner restraining the walls; this may be achieved by dead load in seismic design or in lower wind hazard regions depending on wind exposure and building configuration. The intent of tests was to simulate minimum partial restraint in an actual building for the purpose of evaluating impact on unit shear strength and behavior of the wall. Corners provided improved ductility over walls without any restraint (see Ref #17) and strength comparable to walls with hold-downs, but with a modest reduction in peak capacity depending on the degree of partial restraint (4' vs. 2' corner returns)
Method 3 (7/16" OSB + GWB)	E564 (non-cyclic, full restraint)	8'x20' (no openings)	7/16" OSB with 8d (0.113" diam) nails at 6"/12" (report says 8d common, but pneumatic 0.113" fasteners were actually used)	½" GWB install vertical with joints taped, #6 screws at 7"/10" oc edge/field	2x4@16"oc SPF with 16d common framing nails	E546 Wood bottom beam with 5/8" bolts at 24"oc and cut washers, load beam was 4" x 4" steel tube and spacer,, HTT 22 hold-downs on end studs	16,900 lbs (845 plf)	1.15" (100%)	0.25" (65%) 0.5" (85%)	2.06" (80% post peak)	15 k-in	(Ref #18) Other tests were done with openings to confirm max 4:1 panel for use with perforated shear wall equations. – This was used together with Ref #17 to justify minimum 24" wide panel in IRC with R602.10.5 for panels adjacent to window openings.

Method 3 (7/16" OSB + GWB)	E564 (non-cyclic, full restraint)	8'x24' (no openings)	7/16" OSB with 8d pneumatic nails (0.113" x 2-3/8") at 6"/12" oc edge/field	½" GWB install vertical with joints taped, #6 screws at 7"/10" oc edge/field	2x4@16"oc SPF with 16d pneumatic framing nails (0.131" x 3")	E546 Wood bottom beam with bottom plate fastening varying as indicated, load beam was 4" x 4" steel tube with spacer, HTT 22 hold-downs on end studs	By bottom plate anchor: 5/8" bolt with cut washer, 2'oc 22,500 lbs (934 plf) 2-16d (0.131") at 16"oc 20,800 lbs (867 plf) 5/8" bolt at 6'oc 22,000 (917 plf)	1.84" (100%) 1.47" (100%) 2.12" (100%)	0.5" (72%) 0.5" (67%) 0.5" (55%)	2.9" (80% post-peak) 2.24" (80% post-peak) 2.9" (80% post peak)		(Ref #19) Tests provides data to confirm that perforated shear wall method works with base restraints commonly used in conventional construction. Data used to substantiate use of PSW equation for derivation of IRC bracing amounts (see comment with Ref #17) Test of walls with openings not shown here.
Method 3 (7/16" OSB)	E564 (non-cyclic, full restraint)	8'x20' (no openings)	7/16" OSB with 8d pneumatic nails (0.113" x 2-3/8") at 6"/12" oc edge/field	None	2x4@16"oc SPF with 16d pneumatic framing nails (0.131" x 3")	E546 5/8" bolts at 6'oc and cut washers attached to rig, 3.5" x 3.5" steel tube load beam , HTT 22 hold-downs on end studs	9,400 lbs (470 plf)	2.12" (100%)	0.15" (40%)	5.36" (80% post-peak)	45.7 K-in	(Ref #20) This was a baseline test with full restraint for other tests with partial restraint (see additional data from Ref #20 below) Report includes tests of walls with openings (not included here)
Method 3 (7/16" OSB with corners and bolted plates)	E564 (non-cyclic, partial restraint with corners)	8'x20' with 2' or 4' corners as indicated	7/16" OSB with 8d pneumatic nails (0.113" x 2-3/8") at 6"/12" oc edge/field	None	2x4@16"oc SPF with 16d pneumatic framing nails (0.131" x 3")	3.5" x 3.5" steel tube load beam bolted to specimens, bottom plate connection varied as indicated	5/8" bolts (6'oc) + 2' corners with 1 bolt in plate 8,359 lbs (418 plf) + 4'corners with 2 bolt 9,226 lbs (461 plf)	1.64" (100%) 2.64" (100%)	0.14" (40%) 0.19" (40%)	2.62" (80% post peak) 4.65" (80% post-peak)	18.4 K-in 35.4 K-in	(Ref #20) Bolted bottom plates with partial restraint provided by corners

Method 3 (7/16” OSB with corners and nailed plates)	E564 (non-cyclic, partial restraint with corners)	8’x20’ with 2’ or 4’ corners as indicated	7/16” OSB with 8d pneumatic nails (0.113” x 2-3/8”) at 6”/12” oc edge/field	None	2x4@16”oc SPF with 16d pneumatic framing nails (0.131” x 3”) on wood floor deck, 4-16d pn. Nails per 16” of plate	3.5” x 3.5” steel tube load beam bolted to specimens, bottom plate connection varied as indicated	2-ft corner 8,393 lbs (420 plf) 4-ft corner 9,791 lbs (490 plf)	1.62” (100%) 1.8” (100%)	0.13” (40%) 0.14” (40%)	2.36” (80% post-peak) 4.05” (80% post-peak)	16.8 k-in 35 k-in	(Ref #20) Nailed bottom plate wall tests were done on a floor deck constructed of ¾” OSB subfloor and 2x SPF joists
Method 3 (7/16” OSB)	E564 (non-cyclic, no restraint, partial and full restraint as indicated)	4’x8’	7/16”OSB with 8d pn. (0.113”) and 8d common nails as indicated at 6”/12” oc edge/field	None	2x4@16”oc SPF except bottom plate was preservative treated SP.	Load beam was a 0.25” x 3.5” steel plate to allow minimum stiffness of top of wall boundary. Bottom plate bolted using 2 ½” anchor bolts with cut washers; full restraint when provided used Simpson HTT22 on end studs	Full restraint 8d (0.113”) 1,570 lbs (330 plf) 8d (0.131”) 2,240 lbs (560 plf) No restraint (sheathing to plate only) 8d (0.113”) 640 lbs (160 plf) 8d (0.131”) 750 lbs (190 plf)	2.2” (100%) 4.0” (100%) 1.9” (100%) 2.7” (100%)	See report for other deflection data			(Ref #21) Tests were designed to develop mechanics based procedures for accounting for various degrees of restraint conditions of panels in a walls as well as to investigate prediction of sill plate splitting failure mode. A partially-restrained shear wall design methodology was developed and included in Appendix A (based on Forintek Labs and Ni-Karakabeli approach) Design and performance of integral truss plate hold-downs (between end studs and plates) were also investigated.

Method 3 (Whole Bldg Test)	Whole House (pseudo-dynamic cyclic test, partial restraint, no hold-down brackets)	30’ x 40’ L-shaped floor plan with conventional framed walls and roof system	3/8” plywood laid vertically fastened with 0.113” x 2” D-head Senco pneumatic nails at 6”/12”oc edges/field	½” GWB load horizontal with #6 GWB screws spaced at 12”oc along studs at 16”oc along plates	1.4” x 3.5” studs at 16” oc, radiata pine (similar to SYP and DF) framing nails were 0.120”x3” Senco D-head pneumatic nails	Bottom plate fastened with ½” diam. bolts at about 3.3’ oc on avg (varied) Top plate tied to roof with clips (no blocking). Roof diaphragm typical ½” WSP unblocked construction with GWB ceiling	Exterior Walls (Ply + GWB): 675 plf to 950 plf ultimate (avg 773 plf) Interior Wall (GWB 2-side) 228 plf (max, recorded, not loaded to ultimate)	The house resisted a max total direct shear load of 22,500 lbs with a drift at max load of about 1.26”	Drift here is horizontal movement of the roof diaphragm or house in direction of load. See report for individual wall data.	Past the peak load of 22,500 lbs and drift of 1.26”, the house continued to resist 18,000 lbs at 3.1” drift and 15,700 lbs at 4.3 in drift.	NOTE: The conventional unblocked roof/ceiling diaphragm distributed loads to walls most accurately predicted using a rigid diaphragm (relative wall stiffness) model.	(Ref #22) Load data is based on length of solid wall segments, not total wall lengths. Correcting the data for SPF lumber (multiply by 0.9) the range of ultimate shear would be 608 plf to 855 plf with a typical ultimate value of about 616 plf. This value is within 3% of the value of 634 plf ultimate used for IRC Method 3 (see Ref #17 above) even though a lesser WSP sheathing nail size and lesser GWB attachment was used in this study. Direct and torsional shear loading placed on building. Walls parallel to direct shear were continuous sheathed with various and typical openings including windows, doors, sliding door, and garage door sizes (however, no components were installed in the wall). Loads into each wall were separately instrumented.
Method 4	E72 (non-cyclic, full restraint)	8’x8’	½” fiberboard (19.4 lbs/cuft) with 1-1/2” galv. roofing nails, 4”/8” edge/field	½” GWB with 1-1/4” long GWB-54 nails at 8”oc all framing, edges and field (joints taped)	2x3 @ 16”oc, C&S Grade, WC Hemlock	? (probably bolted to 4x4 load and reaction beams)	5905 lbs (738 plf)	Need to get full report with L-D plots	0.18” (20%)	0.3” (40%)		(see ref#1, wall type 6)
Method 4	E72 (non-cyclic, full restraint)	8’x8’	½” fiberboard (19.4 lbs/cuft) with 1-1/2” galv. roofing nails, 4”/8” edge/field	½” GWB with 1-1/4” long GWB-54 nails at 8”oc all framing, edges and field (joints taped)	2x4 @ 24”oc C&S Grade, WC Hemlock	? (probably bolted to 4x4 load and reaction beams)	4570 lbs (571 plf)	Need to get full report with L-D plots	0.21” (26%)	0.37” (53%)		(see ref#1 wall t ype 7) This test was used in IRC to establish Method 4 bracing percents and also all other methods than Method 3. Design value = [571/2]x0.8 = 228 plf based on safety factor of 2 and 0.8 factor to adjust to partial restraint similar to effect seen with partially restrained Method 3 tests. However, IRC requires 3” edge nail spacing, not 4”.
Method 4	E72 (non-cyclic, full restraint)	8’x8’	½” fiberboard (19.4 lbs/cuft) with 1-1/2” galv. roofing nails, 4”/8” edge/field	½” GWB with 1-1/4” long GWB-54 nails at 8”oc all framing, edges and field (joints taped)	2x3 @ 24”oc C&S Grade, WC Hemlock	? (probably bolted to 4x4 load and reaction beams)	5185 lbs (648 plf)	Need to get full report with L-D plots	0.14” (23%)	0.28” (46%)		(see ref#1 wall type 11)

Method 4 (various panel aspect ratios)	E2126 (cyclic, fully restrained)	8'x8' (1:1) 8'x4' (2:1) 8'x2.7'(3:1) 8'x2' (4:1)	½" fiberboard structural sheathing (ASTM C 208) fastened with galv. roofing nails (0.120" x 1.5" with 7/16" head) at 3"/6" oc (edge/field); nail ¾" inch from edge on perimeter, 3/8" on intermediate vert. joints	None	2x4 @ 16"oc (12"oc used for 4:1 panel test), SYP (G=0.57); framing nails 16d pn. (0.131"x3.25")	½" anchor bolts max 48"oc and minimum of 2 per wall and 8" from ends; 4"x4"x1/4" steel tube load beam; Simpson HTT16 used to anchor doubled end studs	1:1 5860 lbs (730 plf) 2:1 2680 lbs (670 plf) 3:1 1495 lbs (560 plf) 4:1 1075 lbs (540 plf)	1:1 2.9" 2:1 3.5" 3:1 4.4" 4:1 4.9"	1:1 0.3" (27%) 2:1 0.7" (30%) 3:1 0.8" (36%) 4:1 1.1" (37%)	1:1 0.7" (55%) 2:1 1.3" (60%) 3:1 2.0" (71%) 4:1 2.6" (74%)	1:1 1.7" (82%) 2:1 2.7" (90%)		(see ref #3) Anchor bolts and hold-down bolt was pretension to approximately 500 lbs (or ½ turn of nut past finger tight); peak unit shear decreased by about 8% for each increase in panel aspect ratio and drift at peal load increased by about 24% for each increase in panel aspect ratio. Data reported here is based on positive excursion only.
Method 4 (2" edge fastening w/ nails and staples)	E72 (non-cyclic, full restraint)	8'x8'	½" fiberboard fastened at 2"/6"oc (edge/field) with edge distance of ¾" on perimeter and ½" at central stud vert. joint	None	2x4@16"oc, No2 DF	3 lag screws to bottom plate; 4x4 load beam bolted to top plate	11g 1-3/4" roofing nail 5780 lbs (723 plf) COV=5% 16gx 7/16" x 1-3/4" staple 5042 lbs (630 plf) COV= 6% 16g 1" x 1-3/4" staple 7590 lbs (949 plf) COV=4%	Not reported	0.125" (19%) COV=10% 0.125" (19%) COV=34% 0.125" (17%) COV=13%	0.5" (54%) 0.5" (56%) 0.5" (45%)			(see ref#4) Safety factor of 2.8 applied to avg. ult. Proposed in test report per APA Res. Rep. #154. 25/32" sheathing also tested but values were similar (nailed values were 4% greater and staple values were about 4% less)
Method 4	E564 (non-cyclic, full restraint)	4'x8'	½" fiberboard per ASTM C209 with 11ga. Galv. roofing nails (0.120" x 1.5" x 3/8" head) at 4"/6" edge/field (nails located at ¾" from sheathing edges)	None	2x4@16"oc, SPF (Stud/btr)	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	1520 lbs (380 plf)	3.4" (100%)	0.5" (53%)	4.6" (80% post-peak)		0.49 k-ft	(see Ref #5)

Method 4 (plus GWB)	E564 (non-cyclic, full restraint)	4'x8'	½" fiberboard per ASTM C209 with 11ga. Galv. roofing nails (0.120" x 1.5" x 3/8" head) at 4"/6" edge/field (nails located at ¾" from sheathing edges)	½" GWB ASTM C36 with 11ga galv. roofing nail (0.120"x1.5" x 3/8" head) at 7"/16" edge/field	2x4@16"oc, SPF (Stud/btr)	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	2920 lbs (730 plf)	2.61" (100%)	0.5" (52%)	3.7" (80% post-peak)		0.6 k-ft	(see Ref #5)
Method 4	E2126 (cyclic, full restraint) SPD hysteresis	4'x8'	½" fiberboard per ASTM C209 with 11ga. Galv. roofing nails (0.120" x 1.5" x 3/8" head) at 4"/6" edge/field (nails located at ¾" from sheathing edges)	None	2x4@16"oc, SPF (Stud/btr)	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	1460 lbs (365 plf)	2.52" (100%)	0.5" (58%)	4.29" (80% post-peak)		4.33 k-ft	(see Ref #5, Table 10) Data reported here based on average of pos-neg initial cycle backbone curve
Method 4 (plus GWB)	E2126 (cyclic, full restraint) SPD hysteresis	4'x8'	½" fiberboard per ASTM C209 with 11ga. Galv. roofing nails (0.120" x 1.5" x 3/8" head) at 4"/6" edge/field (nails located at ¾" from sheathing edges)	½" GWB ASTM C36 with 11ga galv. roofing nail (0.120"x1.5" x 3/8" head) at 7"/16" edge/field	2x4@16"oc, SPF (Stud/btr)	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	2060 lbs (515 plf)	1.96" (100%)	0.5" (68%)	3.78" (80% post-peak)		5.80 k-ft	(see Ref #5, Table 10) Data reported here based on average of pos-neg initial cycle backbone curve

Method 4	E2126 (cyclic, no restraint) SPD hysteresis	4'x8'	½" fiberboard per ASTM C209 with 11ga. Galv. roofing nails (0.120" x 1.5" x 3/8" head) at 4"/6" edge/field (nails located at ¾" from sheathing edges)	None	2x4@16"oc, SPF (Stud/btr)	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	710 lbs (178 plf)	1.48" (100%)	0.5" (63%)	2.28" (80% post-peak)		1.56 k-ft	(see Ref #5, Table 12) Data reported here based on average of pos-neg initial cycle backbone curve
Method 4 (plus GWB)	E2126 (cyclic, no restraint) SPD hysteresis	4'x8'	½" fiberboard per ASTM C209 with 11ga. Galv. roofing nails (0.120" x 1.5" x 3/8" head) at 4"/6" edge/field (nails located at ¾" from sheathing edges)	½" GWB ASTM C36 with 11ga galv. roofing nail (0.120"x1.5" x 3/8" head) at 7"/16" edge/field	2x4@16"oc, SPF (Stud/btr)	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	680 lbs (170 plf)	1.29" (100%)	0.5" (87%)	2.14" (80% post-peak)		1.49 k-ft	(see Ref #5, Table 12) Data reported here based on average of pos-neg initial cycle backbone curve
Method 4	E72 (non-cyclic, full restraint)	8'x8'	½" fiberboard of various densities as indicated, 11g x 1-1/2" galv. roof ing nails at 3"/6" edge/field	None	2x4@16"oc DF No2&Btr	Typical per E72	3,530 lbs or 441 plf (reg. density, 18-21 pcf) 3,980 lbs or 489 plf (int. density, 22-24 pcf) 6,380 lbs or 797 plf (nail base, 25-30 pcf)	Not reported	0.5" (67%) Based on reg. density				(see Ref #7, Table 1) Data is average of 3 to 5 tests per density class of sheathing

Method 5 (Gyp Shtg)	E72 (non-cyclic, full restraint)	8'x8'	½" Gypsum sheathing with 1-1/2" galv. roofing nails, 4"/8" edge/field	½" GWB with 1-1/4" long GWB-54 nails at 8"oc all framing, edges and field (joints taped)	2x4 @ 24"oc, C&S Grade, WC Hemlock	? (probably bolted to 4x4 load and reaction beams)	5320 lbs (665 plf)	Need to get full report with L-D plots	0.120" (23%)	0.22" (45%)			(see ref #1, wall type 8)
Method 5 (Gyp Shtg)	E72 (non-cyclic, full restraint)	8'x8'	½" Gypsum sheathing with 1-1/2" galv. roofing nails, 4"/8" edge/field	½" GWB with 1-1/4" long GWB-54 nails at 8"oc all framing, edges and field (joints taped)	Same as above except 2x3 @ 16"oc	? (probably bolted to 4x4 load and reaction beams)	6205 lbs (775 plf)	Need to get full report with L-D plots	0.11" (19%)	0.2" (39%)			(see ref #1, wall type 10)
Method 5 (GWB, one-side, partitions)	E72 (non-cyclic, full restraint)	8'x8'	None	1/.2" Gypsum wall board with 1-1/4" annular ring GWB nails at 8"/8" edge/field (joints taped); vert/horiz. installation not specified (probably vert.)	Not reported (probably studs at 16"oc, species unknown, probably No1 SP)	3-bolts/each along top and bottom plate to "timber" load and reaction beams	2467 lbs (308 plf) (COV = 10%, 3 tests)	Plots or data with deflection at ultimate load not shown	0.12" (32%) COV=22%	0.22" (49%) COV=19%	0.68" (96%)		(see ref #2, wall constr #1) -verify that these tests were of a one-sided GWB application
Method 5 (GWB, one-side, 4"/8" fastening	E72 (non-cyclic, full restraint)	8'x8'	None	1/.2" Gypsum wall board with 1-1/4" annular ring GWB nails at 4"/8" edge/field (joints taped); vert/horiz. installation not specified (probably vert.)	Not reported (probably studs at 16"oc, species unknown, maybe No1 SP)	3-bolts/each along top and bottom plate to "timber" load and reaction beams	3900 lbs (487 plf) COV=9% (3 tests)	Plots or data with deflection at ultimate load not shown	0.17" (31%) COV=4%	0.39" (60%) COV=5%			(see ref #2, wall Constr #3); Compare with wall constr #1 above, halving the edge nail spacing increases strength by factor of 1.58.

Method 5 (GWB, one side, 7”/16” fastening	E564 (non-cyclic, full restraint)	4’x8’	None	½” GWB ASTM C36 with 11ga galv. roofing nail (0.120”x1.5” x 3/8” head) at 7”/16” edge/field	2x4@16”oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8” anchor bolts per plate with 2.5”x2.5”x1/4” plate washers; 3”x5” steel tube load beam; double end studs anchored with USP HTT22 hold-downs	1000 lbs (250 plf)	2.24”	0.5” (70%)	4.1” (80% post-peak)		0.3 k-ft	(see Ref #5, Table 7)
Method 5 (GWB, one side, 7”/16” fastening	E2126 (cyclic, full restraint) SPD hysteresis	4’x8’	None	½” GWB ASTM C36 with 11ga galv. roofing nail (0.120”x1.5” x 3/8” head) at 7”/16” edge/field	2x4@16”oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8” anchor bolts per plate with 2.5”x2.5”x1/4” plate washers; 3”x5” steel tube load beam; double end studs anchored with USP HTT22 hold-downs	840 lbs (210 plf)	1.71” (100%)	0.5” (78%)	2.55” (80% post-peak)		1.13 k-ft	(see Ref #5, Table 10) Data reported here based on average of pos-neg initial cycle backbone curve
Method 5 (GWB, one side, 7”/16” fastening	E2126 (cyclic, no restraint) SPD hysteresis	4’x8’	None	½” GWB ASTM C36 with 11ga galv. roofing nail (0.120”x1.5” x 3/8” head) at 7”/16” edge/field	2x4@16”oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8” anchor bolts per plate with 2.5”x2.5”x1/4” plate washers; 3”x5” steel tube load beam; double end studs anchored with USP HTT22 hold-downs	440 lbs (110 plf)	1.42” (100%)	0.5” (85%)	2.11” (80% post-peak)		1.12 k-ft	(see Ref #5, Table 12) Data reported here based on average of pos-neg initial cycle backbone curve
Method 5 (GWB both sides)	E72 (non-cyclic, full restraint)	8’x8’	½” GWB with 1-1/4” GWB nails at 8”/8” edge/field	½” GWB with 1-1/4” GWB nails at 8”/8” edge/field	2x4@24”oc DF (may be typo and really WC Hem)	Not reported, but see other tests per Ref#1 in this table	4,000 lbs (500 plf)	Not reported	0.1” (18%)				(see Ref #5, Table 4-3, based on data from Ref #1)
Method 5 (GWB both sides)	E72 (non-cyclic, full restraint)	8’x8’	½” GWB with 1-1/4” GWB nails at 8”/8” edge/field	½” GWB with 1-1/4” GWB nails at 8”/8” edge/field	2x4@16”oc DF (may be typo and really WC Hem)	Not reported, but see other tests per Ref#1 in this table	4,300 lbs (538 plf)	Not reported	0.1” (30%)				(see Ref #5, Table 4-3, based on data from Ref #1)

Method 5 (GWB both sides)	E72 (non-cyclic, full restraint)	8'x8'	½" GWB with 1-1/4" GWB nails at 16"/16" edge/field plus sides adhesive	½" GWB with 1-1/4" GWB nails at 16"/16" edge/field plus sides adhesive	2x4@24"oc DF (may be typo and really WC Hem)	Not reported, but see other tests per Ref#1 in this table	3,300 lbs (413 plf)	Not reported	0.1" (42%)				(see Ref #5, Table 4-3, based on data from Ref #1)
Method 5 (GWB both sides)	E72 (non-cyclic, full restraint)	8'x8'	½" GWB with 1-1/4" GWB nails at 16"/16" edge/field plus sides adhesive	½" GWB with 1-1/4" GWB nails at 16"/16" edge/field plus sides adhesive	2x4@16"oc DF (may be typo and really WC Hem)	Not reported, but see other tests per Ref#1 in this table	4,000 lbs (500 plf)	Not reported	0.1" (33%)				(see Ref #5, Table 4-3, based on data from Ref #1)
Method 5 (GWB one side)	E564 (non-cyclic, end stud fully restrained, top plate unrestrained)	8'x8'	None	½" GWB (vertical) with 1-1/4" GWB nails at 8"oc along all members, taped and spackled center joint	2x4@24"oc SPF Const Gr, 16d common framing nails, single end stud and single top and bottom plate (OVE framing)	Typical for E72 (4x4 wood load beam with two bolts from plate to beam)	1167 lbs (146 plf) (COV=10%)	Not reported	0.1" (51%)	0.2" (71%)	0.5" (94%)		(see Ref #8, Table 2) See previous Method 1 tests from Ref#1 for comparison of braces with and without GWB under no-restraint (E564)
Method 5 (GWB one side, 16' long wall)	E564 (non-cyclic, end stud fully restrained)	8'x16'	None	½" GWB (vertical) with 1-1/4" GWB nails at 8"oc along all members, taped and spackled center joint	2x4@24"oc SPF Const Gr, 16d common framing nails, single end stud and single top and bottom plate (OVE framing)	Typical for E72 (4x4 wood load beam with two bolts from plate to beam)	2450 lbs (153 plf) (COV=10%)	0.45" (100%)	0.1" (57%)	0.2" (84%)	0.5" (94%)		(see Ref #8, Table 3) See previous Method 1 and Method 5 data from Ref #8 for comparison With one 1x4 let-in brace in compression added, the increased resistance was 450 lbs to 2,900 lbs total

Method 5 (GWB one side, 24' long wall)	E564 (non-cyclic, end stud fully restrained)	8'x24'	None	½" GWB (vertical or horizontal as indicated) with 1-1/4" GWB nails at 8"oc along all members, taped and spackled center joint	2x4@24"oc SPF Const Gr, 16d common framing nails, single end stud and single top and bottom plate (OVE framing)	Typical for E72 (4x4 wood load beam with two bolts from plate to beam)	Vertical GWB: 4,100 lbs (171 plf) Horiz. GWB: 6,000 lbs (250 plf)	Vertical 0.4" (100%) Horiz. 0.35" (100%)	Vertical 0.1" (63%) Horiz. 0.1" (65%)	Vertical 0.2" (88%) Horiz. 0.2" (82%)			(see Ref #8, Table 3) See previous Method 1 and Method 5 data from Ref #8 for comparison With one 1x4 let-in brace in compression added to each GWB application, the increased resistance was 100 lbs and 600 lbs for the vert. and horiz. GWB respectively. This suggests that let-in brace strength of about 600 lbs (in unrestrained test) is only added with GWB when GWB is horizontally placed (nails in plates resist uplift through paper wrapped edge of GWB)
Method 5 (lath and plaster interior finish)	Similar to E72 (non-cyclic, fully restrained)	9'x14'	None	¼"x4' wood lath strips applied to framing with 3d nails, two coats of plaster	2x4@16"oc No1 common	Similar to E72 with plates bolted to timber top and bottom beams	11,400 lbs (814 plf)	Not reported					(see Ref #10, Table 1) With horizontal and diagonal board sheathing added to opposite face resistance was 14,500 lbs (1,036 plf) and 20,300 lbs (1,450 plf), respectively (for comparison see tests reported earlier without interior plaster)
Method 5 (one side, ½" GWB, 7"/7")	E72 (non-cyclic, fully restrained)	8'x8'	None	½" GWB with 5d cooler (0.092" x 1-5/8") nails at 7"/7" oc edges/field (horiz. unblocked)	2x4@16"oc West Hem	Typical E72, steel load beam, bolted bottom plate with steel plate washers	2030 lbs (254 plf)	0.48" (94%)					(see Ref #13, Table 2)

Method 7 (PC Stucco w/ GWB	Unique Set-up, wall restrained with 450 plf dead load (cyclic, partial restraint) CUREe protocol	8'x16' (with window and/or door openings)	7/8" PC stucco (3-coat) with 17g hexagonal self-furring woven-wire lath with furring nails (0.1055"x1-1/2") at 6"oc	½" GWB with 5d cooler (0.092" x 1-5/8") nails at 7"/7" oc edges/field (horiz. unblocked, butt joints staggered)	2x4@16"oc DF framing nails were 16d common	Top plate lags to steel load beam with dead load applied to beam, bottom plate with ½" anchor bolts at no more than 6'oc, no hold-downs	1,590 plf to 1,880 plf (for wall with window & door and wall with windows only, respectively) Avg = 1,735 plf	0.97 to 1.1" at peak load (for wall with windows only and window/door, respectively) 80% post peak load occurs at 2 to 2.5% drift (about 2" drift)	0.19" (at 50% of peak load) 785 plf to 942 plf wall with 2 windows has higher value (stiffer) Barely visible damage/cracking of stucco and GWB	0.38" (at 65 to 70% of peak load) 1,032 plf to 1,308plf wall with two windows has higher value (stiffer) Cracks widen and extended, some softening of stiffness, nail pops in GWB	0.67" (at about 90% of peak load) 1,361 plf to 1,682 plf. GWB crushing and opening at corner cracks, flaking and spalling of stucco	(Ref #23) Ultimate shear values are based on net wall length (e.g., load divided by length of wall less width of windows and doors); full-height segment widths between openings were 2'+4'+2' (wall with 2 windows) and 2'+5.3'+2' (wall with door and window); if the 2' segments are discounted due to aspect ratio > 2:1, then the net load values would essentially double. This speaks to the conservatism of ignoring narrow wall segments in residential bracing and design practice in general.	
Method 7 (PC Stucco alone)	E72 (on-cyclic, fully restrained)	8'x8'	7/8" PC stucco with wire mesh or expanded metal lath, 6"oc fastening with nails or staples	None	2x4@16"oc (?)	Typical E72	490 plf to 1,580 plf Stapled connections tended to give values above 750 plf	?	?			(Ref #24) – data based on several different reports Note that the monolithic stucco shell was not continuous at the perimeter of the wall or ends as in Ref #23; this probably explains the lower values to some degree	
Method 8 Hardboard Panel Siding	E564 (non-cyclic, full restraint)	4'x8'	3/8" hardboard per ANSI/AHA 135.4 and 135.6 fastened with 6d box nails (0.099" x 2" x 0.266" head) at 4"/8" oc edge/field, nails located with ¾" edge distance	None	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	2080 lbs (520 plf)	2.26" (100%)	0.5" (67%)	4.61" (80% post-peak)		0.7 k-ft	(see Ref #5, Table 7)

Method 8 (plus GWB)	E564 (non-cyclic, full restraint)	4'x8'	3/8" hardboard per ANSI/AHA 135.4 and 135.6 fastened with 6d box nails (0.099" x 2" x 0.266" head) at 4"/8" oc edge/field, nails located with ¾" edge distance	½" GWB ASTM C36 with 11ga galv. roofing nail (0.120"x1.5" x 3/8" head) at 7"/16" edge/field	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	2920 lbs (730 plf)	1.98" (100%)	0.5" (77%)	4.5" (80% post-peak)		0.92 k-ft	(see Ref #5, Table 7)
Method 8 Hardboard Panel Siding	E2126 (cyclic, full restraint) SPD hysteresis	4'x8'	3/8" hardboard per ANSI/AHA 135.4 and 135.6 fastened with 6d box nails (0.099" x 2" x 0.266" head) at 4"/8" oc edge/field, nails located with ¾" edge distance	None	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	2250 lbs (563 plf)	2.32" (100%)	0.5" (67%)	4.17" (80% post-peak)		7.08 k-ft	(see Ref #5, Table 10) Data reported here based on average of pos-neg initial cycle backbone curve
Method 8 (plus GWB)	E2126 (cyclic, full restraint) SPD hysteresis	4'x8'	3/8" hardboard per ANSI/AHA 135.4 and 135.6 fastened with 6d box nails (0.099" x 2" x 0.266" head) at 4"/8" oc edge/field, nails located with ¾" edge distance	½" GWB ASTM C36 with 11ga galv. roofing nail (0.120"x1.5" x 3/8" head) at 7"/16" edge/field	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	2870 lbs (718 plf)	2.36" (100%)	0.5" (63%)	4.19" (80% post-peak)		7.68 k-ft	(see Ref #5, Table 10) Data reported here based on average of pos-neg initial cycle backbone curve

Method 8 Hardboard Panel Siding	E2126 (cyclic, no restraint) SPD hysteresis	4'x8'	3/8" hardboard per ANSI/AHA 135.4 and 135.6 fastened with 6d box nails (0.099" x 2" x 0.266" head) at 4"/8" oc edge/field, nails located with ¾" edge distance	None	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	740 lbs (185 plf)	1.75" (100%)	0.5" (63%)	3.28" (80% post-peak)		2.6 k-ft	(see Ref #5, Table 12) Data reported here based on average of pos-neg initial cycle backbone curve
Method 8 (plus GWB)	E2126 (cyclic, no restraint) SPD hysteresis	4'x8'	3/8" hardboard per ANSI/AHA 135.4 and 135.6 fastened with 6d box nails (0.099" x 2" x 0.266" head) at 4"/8" oc edge/field, nails located with ¾" edge distance	½" GWB ASTM C36 with 11ga galv. roofing nail (0.120"x1.5" x 3/8" head) at 7"/16" edge/field	2x4@16"oc, SPF (Stud/btr) with 16d common framing nails	2- 5/8" anchor bolts per plate with 2.5"x2.5"x1/4" plate washers; 3"x5" steel tube load beam; double end studs anchored with USP HTT22 hold-downs	830 lbs (208 plf)	1.5" (100%)	0.5" (73%)	2.58" (80% post-peak)		1.62 k-ft	(see Ref #5, Table 12) Data reported here based on average of pos-neg initial cycle backbone curve

Table Notes:

Column 1: Bracing methods are based on IRC classification of bracing methods, but connections and various details in the tested walls vary from the "baseline" assembly requirements in the IRC. Available data is grouped in accordance with the 8 bracing methods in the IRC. Specific IRC requirements for installation and fastening of bracing methods are reported separately below and, as mentioned, generally vary from the data reported above.

Column 2: Testing method. Also indicated is whether the test method applies a non-cyclic or cyclic loading. In addition, the test method is classified by three categories of overturning restraint applied to the test specimen ("fully restrained" means overturning is prevented, "partially-restrained" means that overturning restraint is provided at a level between full and no restraint, and "no restraint" means that separate overturning restraint is not provided to the wall specimen). The degree of restraint that may be representative for design of a given building may depend on a the building configuration (e.g., dead load, roof slope/shape, etc.) and the design wind speed. For seismic design, some degree of overturning restraint will be present due to dead load of the building as a minimum.

Columns 3-7: Wall Assembly. These columns are self-explanatory and contain important details related to the wall systems tested as reported.

Columns 8-13: Load-Deflection Data. These columns summarize key results, particularly ultimate tested shear load and unit shear. Deflection or stiffness related data is included as available in the reference document and reporting of this data varies in the literature. To the degree possible, consistency in reporting deflection data is attempted by reporting deflections at a given percentage of the peak load. Also, where reported, energy dissipation data is provided in column 13 as it may be important for relative comparison of tests (along with peak load and deflections) for seismic design considerations. Other seismic-related parameters may be included in some of the references but

are not reported here as the primary focus is on establishing design values for the purpose of wind design and determination of IRC wall bracing amounts for wind conditions addressed in the IRC and lower seismic design categories (e.g., SDC A-C).

Column 14: Comments. This column provides a link to the reference literature listed below and also provide additional insights on the nature of data or related data from other tests or reports.

Table References:

1. Racking Strengths and Stiffnesses of Exterior and Interior Frame Wall Constructions, NAHB Research Foundation for U.S. HUD, 1971.
2. Racking Resistance Test Evaluation for Residential Structures, Phase Two, Prepared for DOW Chemical USA by ICF Kaiser Engineers, February 1991.
3. Cyclic Testing of Fiberboard Shear Walls with Varying Aspect Ratios (EG3209_031506), Prepared by NAHB Research Center for American Fiberboard Association, Palatine, IL. March 15, 2006.
4. Racking Load Tests for American Fiberboard Association, PFS Test Report #96-90, PFS Corporation, Madison, WI. 12/02/96
5. Monotonic and Cyclic Tests of Shear Walls with Gypsum Wallboard, Fiberboard, and Hardboard Sheathing, Report No. WMEL-2002-03, Wood Materials and Engineering Laboratory, Washington State University, Pullman, WA. November 27, 2002.
6. Light-Frame Wall and Floor Systems / Analysis and Performance, FPL-GTR-59, G. Sherwood and R.C. Moody (editors), USDA, Forest Products Laboratory, Madison, WI. February 1989.
7. Racking Strength of Walls: Let-in Corner Bracing, Sheet Materials, and Effect of Loading Rate, FPL 301, by R.L. Toumi and D.S. Gromala, USDA, Forest Products Laboratory, Madison, WI. 1977.
8. Contribution of Gypsum Wallboard to Racking Resistance of Light-Frame Walls, FPL 439, by R. W. Wolfe, USDA, Forest Products Laboratory, Madison, WI. December 1983.
9. Racking Strength of Walls Sheathed with Structural Flakeboards Made from Southern Species, by E. W. Price and D. S. Gromala (USDA-FPL), Forest Products Journal, Vol. 30, No. 12, Forest Products Society, Madison, WI. 1980.
10. The Rigidity and Strength of Frame Walls, No. 896, USDA Forest Products Laboratory, Madison, WI. March 1956 (reviewed and reaffirmed data from 1929).
11. Shear Resistance of Wood Frame Walls, by A.T. Hansen, National Research Council Canada, Ottawa, Canada, December 1985. (data from this report was in general agreement with other sources but is not reported here because of a lack of description of test method used and other relevant information for proper interpretation)
12. Adequacy of Light Frame-Wall Construction, No. 2137, by R.F. Luxford and W. E. Bonser, USDA Forest Products Laboratory, Madison, WI. November 1958.
13. Wood Structural Panel Shear Walls with Gypsum Wallboard and Window/Door Openings, Report 157, by J.D.Rose and E. L. Keith, APA- The Engineered Wood Association, Tacoma, WA. November 1996.
14. Wood Structural Panel Lateral and Shear Wall Connections with Common, Galvanized Box, and Box Nails, APA Report T2004-14, by Z. A. Martin, APA-The Engineered Wood Association, Tacoma, WA. June 23, 2004.
15. Monotonic Tests of Wood-frame Shear Walls with Various Openings and Base Restraint Configurations, Report No. TE-1997-001, by J.D. Dolan and C.P. Heine, Brooks Forest Products Research Center, VPI&SU, Blacksburg, VA. September 14, 1997.

16. Sequential Phased Displacement Cyclic Tests of Wood-frame Shear Walls with Various Openings and Base Restraint Configurations, Report No. TE-1997-002, by J.D. Dolan and C.P. Heine, Brooks Forest Products Research Center, VPI&SU, Blacksburg, VA. September 14, 1997.
17. Sequential Phased Displacement Tests of Wood-frame Shear Walls with Corners, Report No. TE-1997-003, by J.D. Dolan and C.P. Heine, Brooks Forest Products Research Center, VPI&SU, Blacksburg, VA. September 14, 1997.
18. The Performance of Perforated Shear Walls with Narrow Wall Segments, Reduced Base Restraint, and Alternative Framing Methods, by NAHB Research Center, Inc. for the National Association of Home Builders and the U.S. Department of Housing and Urban Development, Washington, DC. May 1998.
19. Perforated Shear Walls with Conventional and Innovative Base Restraint Connections, by NAHB Research Center, Inc. for the National Association of Home Builders and U.S. Department of Housing and Urban Development, Washington, DC. May 1999.
20. Wood Shear Walls with Corners, by NAHB Research Center, Inc. for the National Association of Home Builders and the U.S. Department of Housing and Urban Development, Washington, DC. March 2001.
21. Light-Frame Wood Shear Walls with Various Overturning Restraints, by NAHB Research Center, Inc. for U.S. Department of Housing and Urban Development, Washington, DC. July 2003.
22. Whole Structure Testing and Analysis of a Light-Frame Wood Building (Three Reports), prepared by NAHB Research Center, Inc. for National Association of Home Builders and U.S. Department of Housing and Urban Development, Washington, DC. July 2001. [a compilation of studies conducted jointly by North Carolina State University (Dr. Bo Kasal) and CSIRO (Dr. Greg Foliente); whole building tests and the three reports were prepared by CSIRO, Highette, Victoria, Australia).
23. Cyclic Behavior and Repair of Stucco and Gypsum Sheathed Woodframe Walls: Phase I, Report No. SSRP-2002/07, A. E. Arnold, C-M Uang, and A. Filiatrault, Department of Structural Engineering, University of California – San Diego, La Jolla, CA. May 2003.
24. Residential Structural Design Guide – 2000 Edition, by NAHB Research Center Inc. for the National Association of Home Builders and U.S. Department of Housing and Urban Development, Washington, DC. 2000.