

APPENDIX A: MONOTONIC TESTS

Test:	1	1a	2	2a
Testing Procedure:	Monotonic	Monotonic	Monotonic	Monotonic
Material:	OSB	OSB	OSB	OSB
Date Constructed:	7/09/02	07/09/02	7/15/02	9/05/02
Date Tested:	7/23/02	7/26/02	7/23/02	9/16/02

Test 1 Observations:

-Nails on the bottom plate pulled out of framing and nail head tried to pull through the sheathing.

Test 1a Observations:

-Nails pulled out of end studs near the ram

-The first three nails pulled through sheathing on the bottom plate near the ram.

-End stud near ram pulled away from the top plate while the 2nd stud pulled away from the bottom plate.

Note: The load did not drop drastically during its six inches of displacement. The wall reached its peak around 2.5" and maintained its load until 5.5".

Test 2 Observations:

-Nails pulled out of end studs near the ram

-The first three nails pulled through sheathing on the bottom plate near the ram.

-End stud near ram pulled away from the top plate while the 2nd stud pulled away from the bottom plate.

Test 2a Observations:

-Nails on the bottom plate pulled out of framing and nail head tried to pull through the sheathing.

Note: This test was performed at a later date than the others to confirm whether the wall would fail or not when the steel guide piece was removed. The frame from Test 8 was salvaged and brought inside on 08/28. The bottom plate had a moisture content of 20%, so it was replaced. It was allowed to dry for over two weeks before testing and the moisture content at the time of testing was about 12%.

Table A.1: Monotonic analysis results of OSB

OSB

		Test 1	Test 1a	Test 2	Test 2a	COV (%)
Max Load, F_{peak}	kips	2.44	2.28	2.63	2.70	7.5
	kN	10.85	10.14	11.68	11.99	
Δ_{peak}	in	-3.52	-3.32	-4.94	-4.35	18.6
	mm	-89.40	-84.35	-125.38	-110.49	
$F_{failure}$ or $0.8F_{peak}$	kips	2.20	2.04	2.60	2.14	10.9
	kN	9.78	9.07	11.56	9.52	
$\Delta_{failure}$	in	-5.07	-5.55	-5.23	-5.69	5.3
	mm	-128.68	-140.85	-132.76	-144.53	
Yield Load, F_{yield}	kips	2.18	2.06	2.30	2.41	6.8
	kN	9.70	9.15	10.23	10.72	
Δ_{yield}	in	-0.25	-0.60	-0.78	-1.12	52.7
	mm	-6.35	-15.32	-19.69	-28.45	
$F_{40\%}$	kips	0.96	0.90	1.04	1.07	7.6
	kN	4.28	4.02	4.63	4.76	
$\Delta_{40\%}$	in	-0.11	-0.26	-0.35	-0.50	53.0
	mm	-2.80	-6.72	-8.90	-12.65	
Energy Dissipated	kip*ft	-0.90	-0.90	-0.93	-1.03	6.7
	kN*m	-1.22	-1.22	-1.26	-1.40	
Elastic Stiffness, K_e @0.4 F_{peak}	kip/in	-8.73	-3.41	-2.97	-2.15	69.2
	kN/mm	-1.53	-0.60	-0.52	-0.38	
Ductility Ratio, μ		20.3	9.2	6.7	5.1	66.3
Initial Load		200	17	-120	-146	

*Test 1a and 2a were performed after the steel guide piece was removed

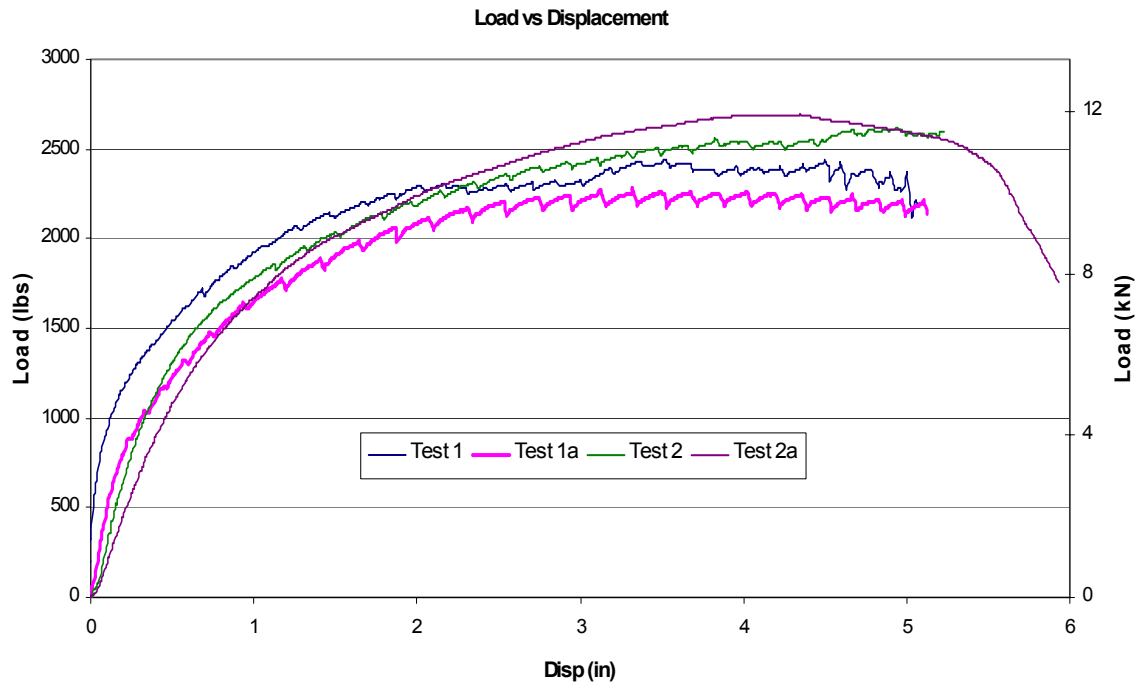


Figure A.1: Load-Displacement graph of OSB

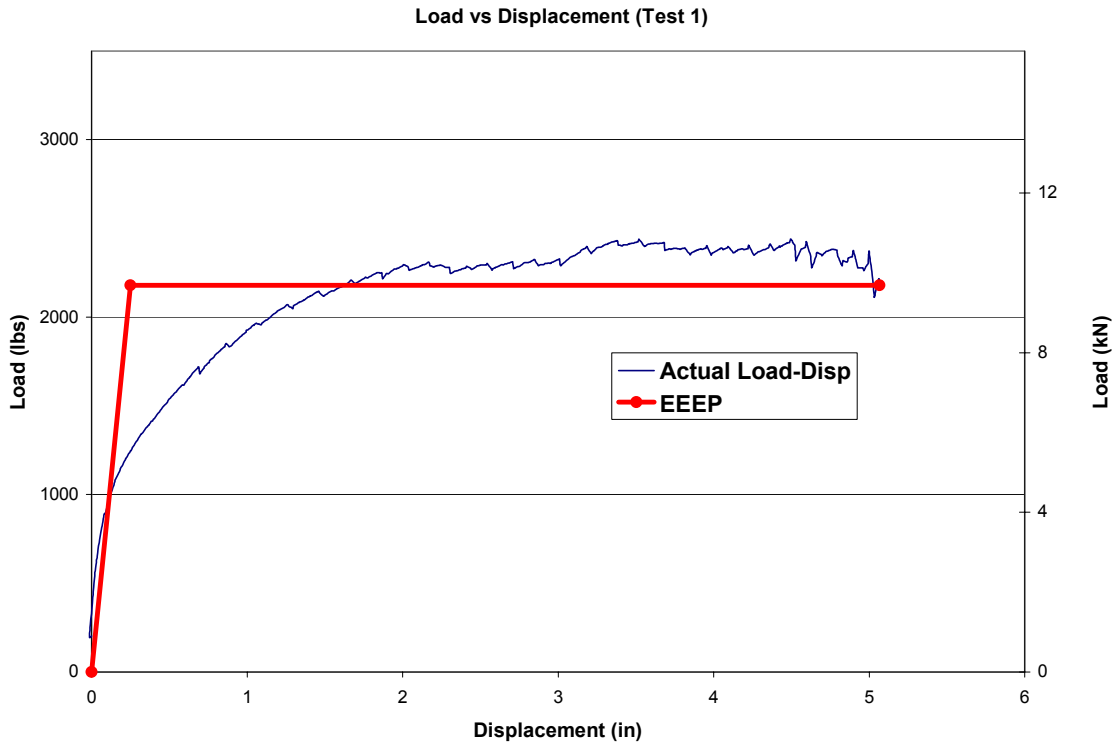


Figure A.2: EEEP curve for Test 1

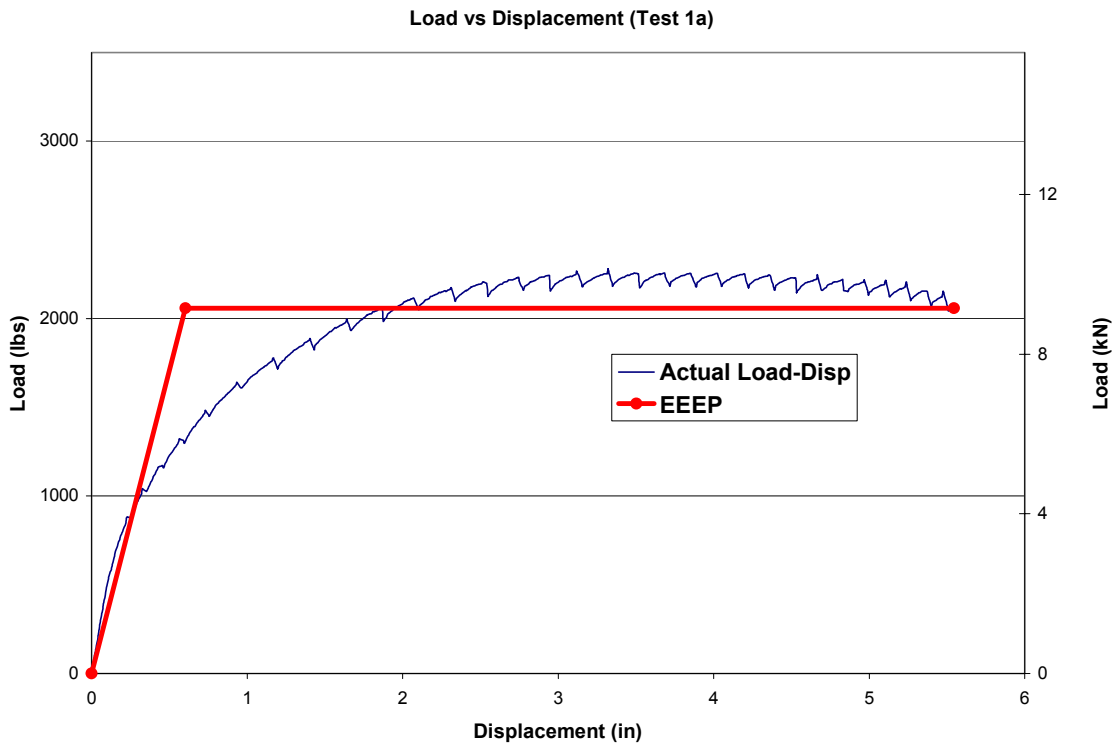


Figure A.3: EEEP curve for Test 1a

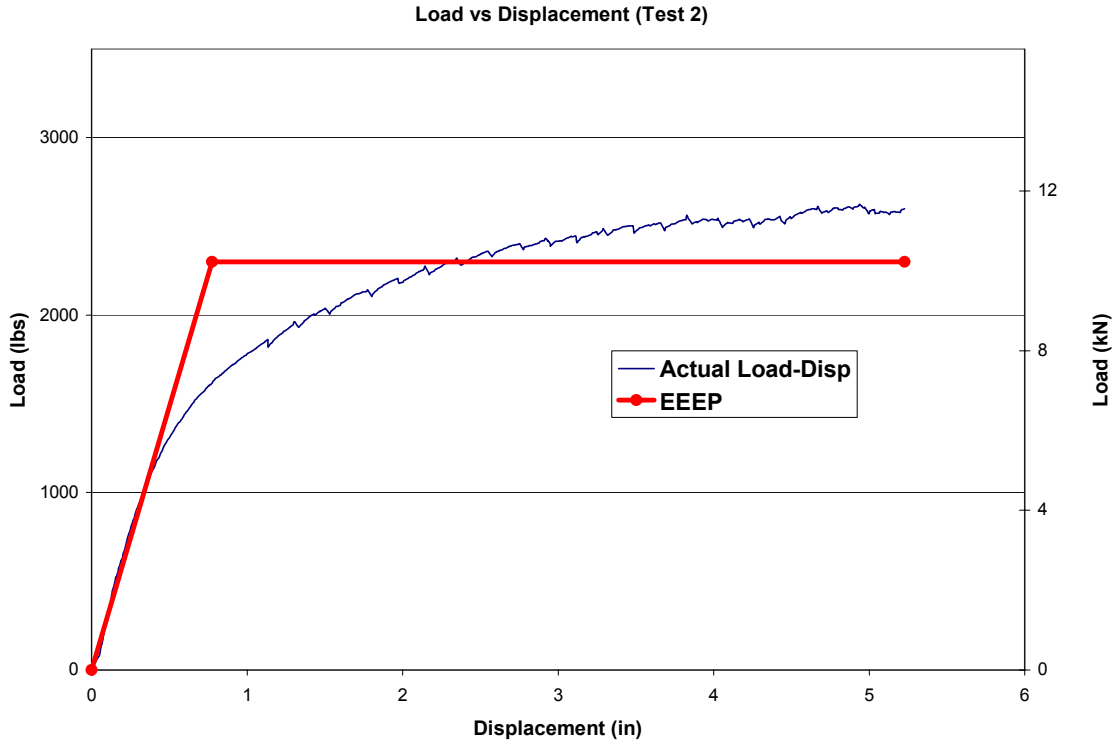


Figure A.4: EEEP curve for Test 2

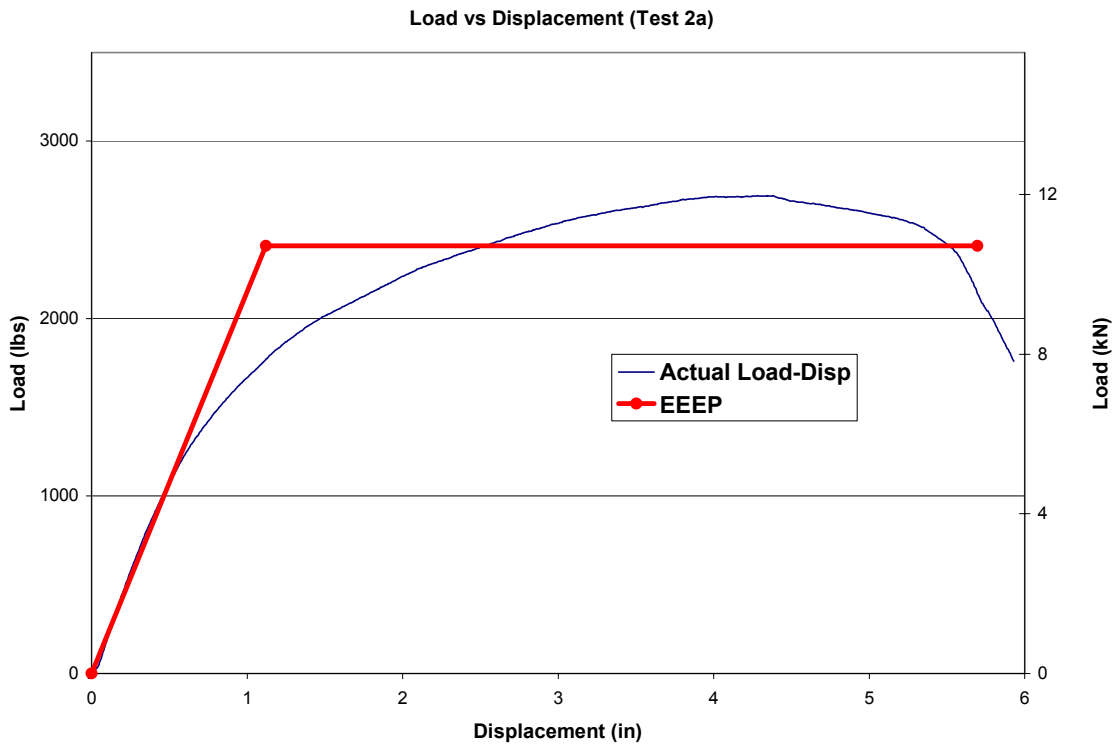


Figure A.5: EEEP curve for Test 2a

Test:	3	3a	4
Testing Procedure:	Monotonic	Monotonic	Monotonic
Material:	Hardboard	Hardboard	Hardboard
Date Constructed:	7/19/02	9/05/02	7/19/02
Date Tested:	7/24/02	9/16/02	7/25/02

Test 3 Observations:

-Nails pulled out of the bottom plate and right end stud. There was very little damage to the sheathing material where the nail holes were.

-All other nails had no apparent damage.

-Right end stud separated from the top plate, while the 2nd stud tried to separate from the bottom plate.

-The right hold-down's anchor bolt was loose after the test was over.

Note: The Steel guide piece inhibited the wall from failing.

Test 3a Observations:

-Nails along the bottom plate and up the right end stud pulled out the framing by a considerable amount.

Note: This test was performed at a later date due to the difference in performance of Test 3 and Test 4. The frame from Test 15 was salvaged and brought inside after its test on 8/02/02. There was minimal damage to this frame because it was first tested with gypsum wallboard, which failed early in the cyclic protocol (refer to Test 15).

Test 4 Observations:

-Some nail pullout was observed on the end stud away from the ram

-All other failure characteristics were the same as Test 3. This wall did fail because the steel guide piece was removed.

Table A.2: Monotonic analysis results of hardboard

Hardboard

		Test 3	Test 4	Test 3a	COV(%)
Max Load, F_{peak}	kip	2.14	1.97	2.14	4.7
	kN	9.52	8.76	9.51	
Δ_{peak}	in	-2.79	-1.65	-2.33	25.3
	mm	-70.80	-41.97	-59.18	
$F_{failure}$ or $0.8F_{peak}$	kip	1.71	1.57	1.71	4.7
	kN	7.60	7.00	7.61	
$\Delta_{failure}$	in	-5.50	-2.89	-5.46	32.4
	mm	-139.82	-73.40	-138.68	
Yield Load, F_{yield}	kip	1.97	1.75	1.94	6.4
	kN	8.78	7.78	8.63	
Δ_{yield}	in	-0.43	-0.40	-0.54	16.8
	mm	-10.92	-10.11	-13.82	
$F_{40\%}$	kip	0.86	0.78	0.85	5.0
	kN	3.80	3.46	3.76	
$\Delta_{40\%}$	in	-0.19	-0.18	-0.24	16.1
	mm	-4.73	-4.50	-6.02	
Energy Dissipated	kip*ft	-0.87	-0.39	-0.84	38.2
	kN*m	-1.18	-0.53	-1.14	
Elastic Stiffness, K_e @0.4 F_{peak}	kip/in	-4.59	-4.39	-3.57	13.0
	kN/mm	-0.80	-0.77	-0.62	
Ductility Ratio, μ		12.8	7.3	10.1	27.6
Initial Load		210	80	19	

*Test 3a and 4 were performed after the steel guide piece was removed

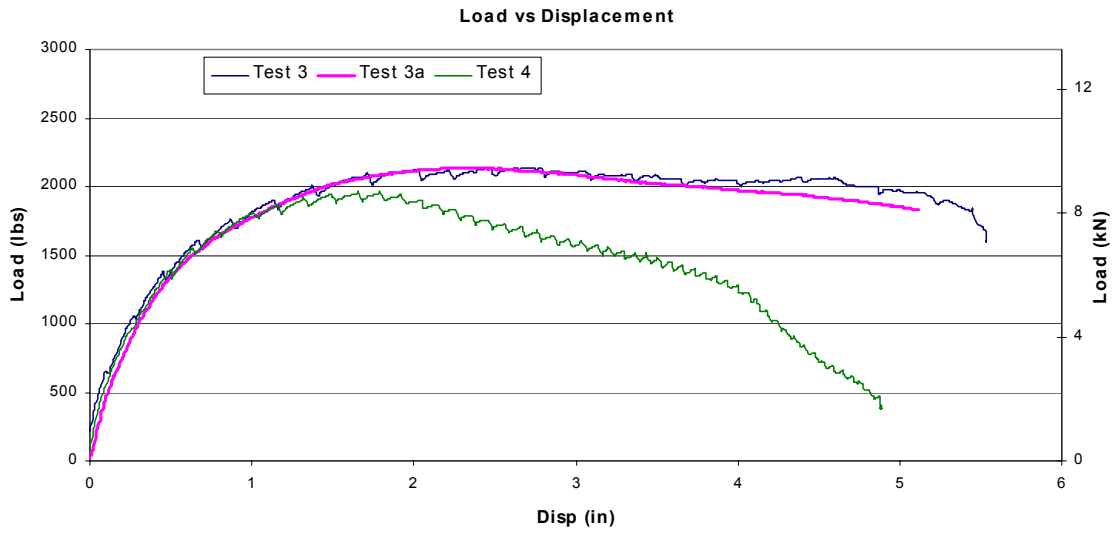


Figure A.6: Load-Displacement graph of hardboard

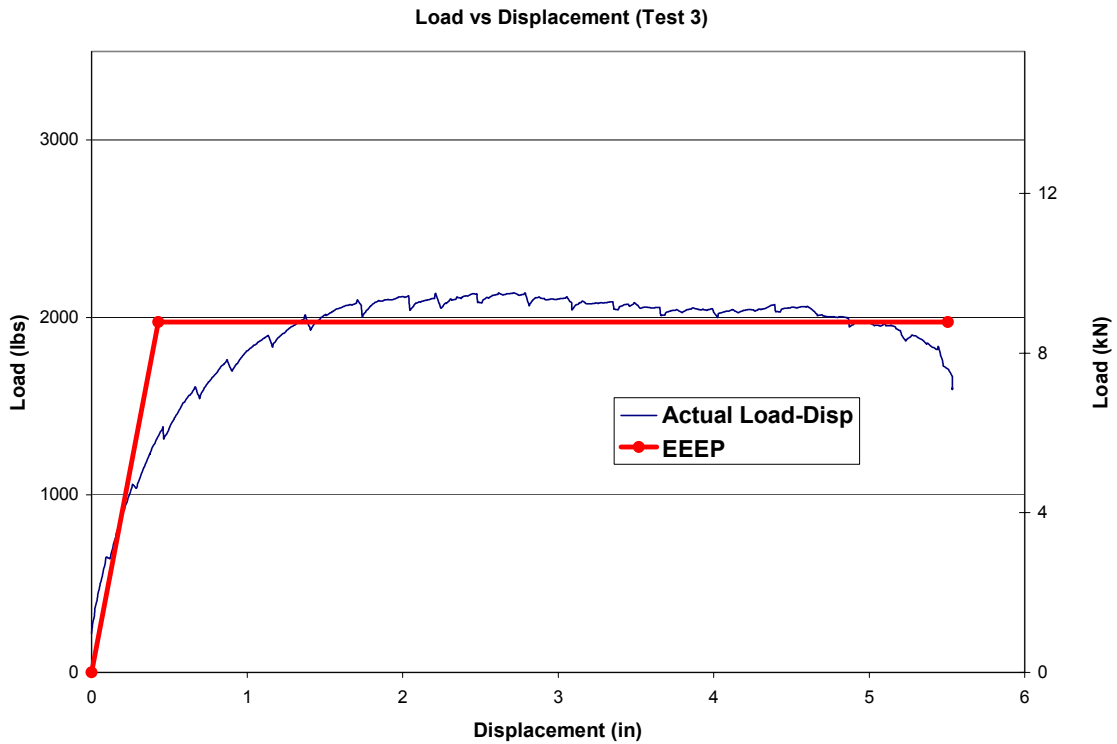


Figure A.7: EEEP curve for Test 3

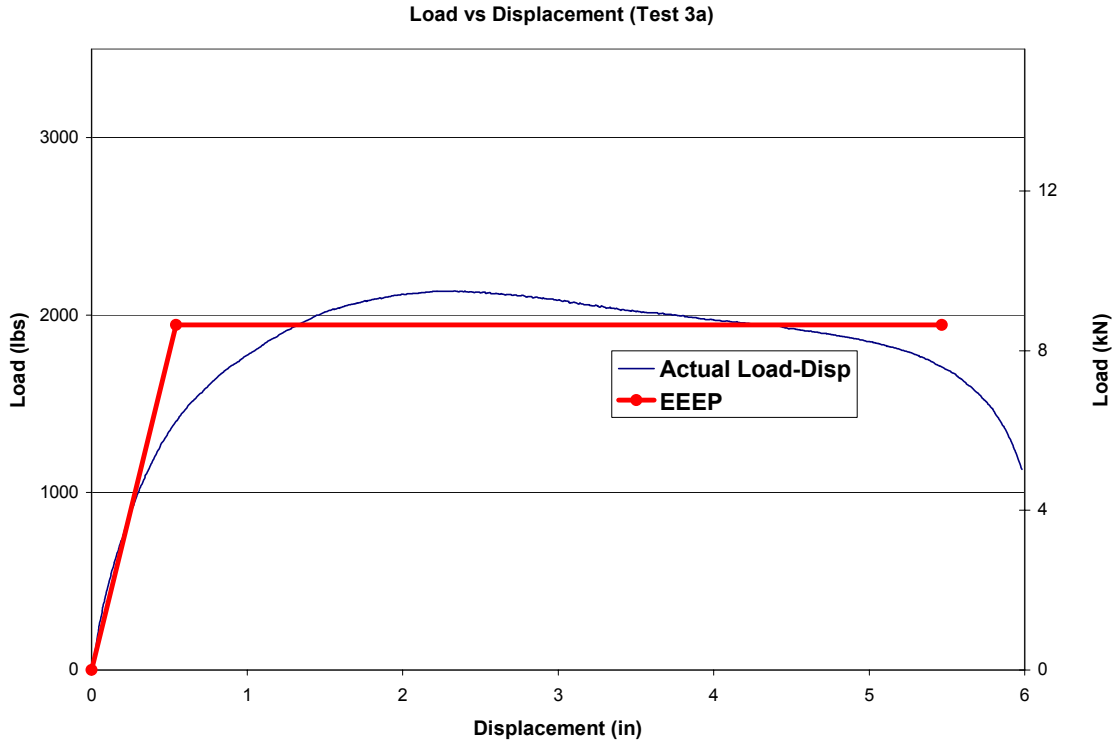


Figure A.8: EEEP curve for Test 3a

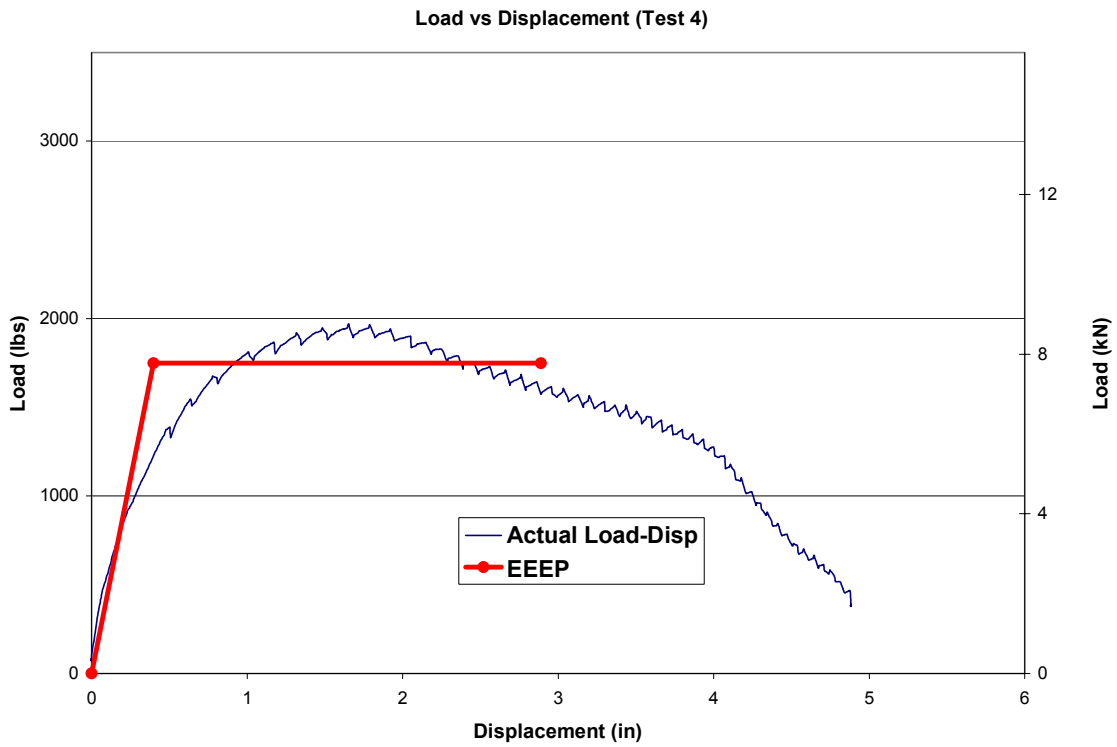


Figure A.9: EEEP curve for Test 4

Test:	5	6
Testing Procedure:	Monotonic	Monotonic
Material:	Fiberboard	Fiberboard
Date Constructed:	7/11/02	07/11/02
Date Tested:	7/25/02	7/25/02

Test 5 Observations:

- Nails pulled out of end studs near the ram
- Nail heads ripped into sheathing on the left end stud.
- Nails pulled through sheathing on bottom plate.
- Failure occurred from the end studs near the ram pulling away from the bottom plate and the 2nd stud pulling away from the bottom plate.

Note: The Steel guide piece inhibited failure of the wall.

Test 6 Observations:

- All nails on the top half of the wall were observed to pull out of the framing.
- Only minor pullout of the nails on the bottom plate.
- No major pull-away of studs from the top or bottom plate was observed.
- Mode of failure determined to be separation of sheathing from framing.

Table A.3: Monotonic analysis results of fiberboard

Fiberboard

		Test 5	Test 6	COV(%)
Max Load, F_{peak}	kips	1.56	1.48	3.9
	kN	6.94	6.57	
Δ_{peak}	in	-4.19	-2.61	32.8
	mm	-106.43	-66.39	
$F_{failure}$ or $0.8F_{peak}$	kips	1.32	1.18	7.8
	kN	5.86	5.24	
$\Delta_{failure}$	in	-5.52	-3.68	28.3
	mm	-140.26	-93.51	
Yield Load, F_{yield}	kips	1.39	1.33	3.3
	kN	6.18	5.90	
Δ_{yield}	in	-0.68	-0.57	13.1
	mm	-17.37	-14.43	
$F_{40\%}$	kips	0.62	0.59	4.0
	kN	2.77	2.62	
$\Delta_{40\%}$	in	-0.31	-0.25	13.7
	mm	-7.79	-6.42	
Energy Dissipated	kip*ft	-0.60	-0.38	32.6
	kN*m	-0.81	-0.51	
Elastic Stiffness, K_e @0.4 F_{peak}	kip/in	-2.03	-2.33	9.7
	kN/mm	-0.36	-0.41	
Ductility Ratio, μ		8.1	6.5	15.5
Initial Load		25	0	

*Test 6 was performed after the steel guide piece was removed

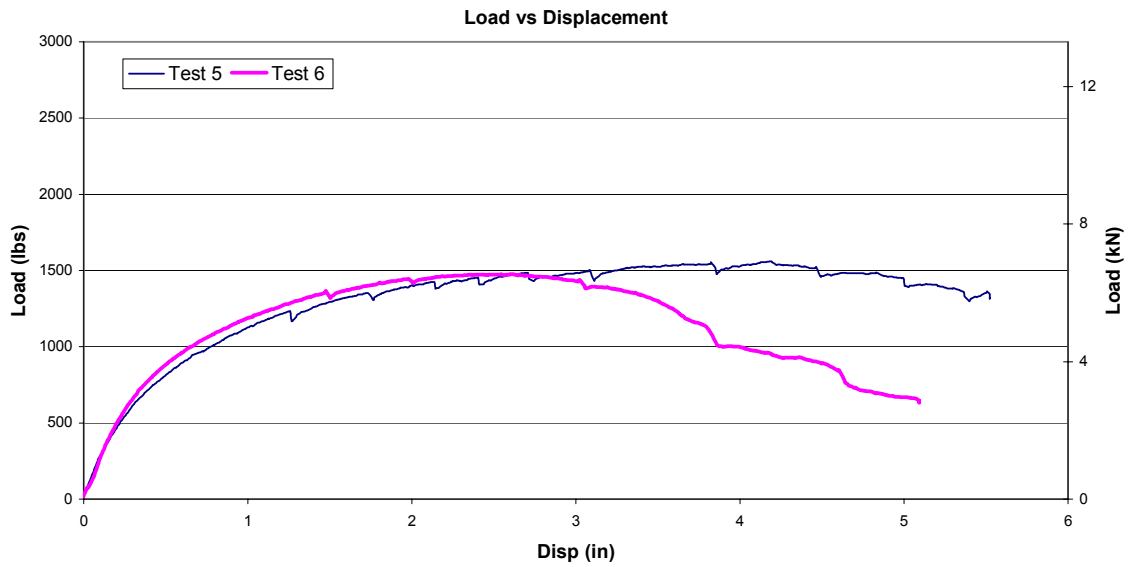


Figure A.10: Load-Displacement graph of fiberboard



Figure A.11: EEEP curve for Test 5

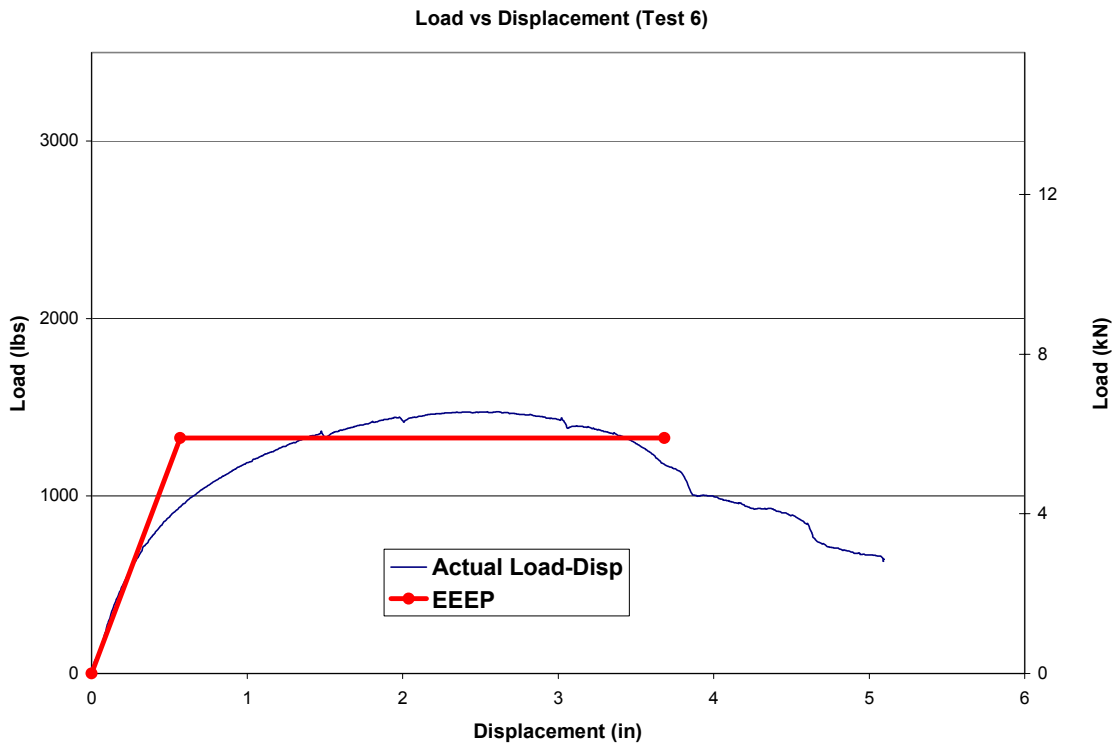


Figure A.12: EEEP curve for Test 6

Test:	7	8
Testing Procedure:	Monotonic	Monotonic
Material:	Gypsum	Gypsum
Date Constructed:	7/12/02	07/12/02
Date Tested:	7/25/02	7/26/02

Test 7 Observations:

- Nails ripped through gypsum most notably along the top and bottom plates
- Nails sank through gypsum along the edges.
- The top plate was observed to pull away from the steel at the ends of the walls.

Test 8 Observations:

- Nails ripped through gypsum most notably along the top and bottom plates
- Nails sank through gypsum along the edges.
- White flakes were noticed on the ground from the nails ripping through the sheathing.

Table A.4: Monotonic analysis results of gypsum wallboard

Gypsum

		Test 7	Test 8	COV(%)
Max Load, F_{peak}	kip	0.96	1.04	5.8
	kN	4.28	4.64	
Δ_{peak}	in	-2.24	-2.23	0.4
	mm	-57.01	-56.67	
$F_{failure}$ or $0.8F_{peak}$	kip	0.77	0.83	5.7
	kN	3.42	3.71	
$\Delta_{failure}$	in	-4.20	-4.01	3.3
	mm	-106.61	-101.73	
Yield Load, F_{yield}	kip	0.86	0.97	7.8
	kN	3.84	4.29	
Δ_{yield}	in	-0.39	-0.44	9.3
	mm	-9.78	-11.15	
$F_{40\%}$	kip	0.38	0.42	5.9
	kN	1.70	1.85	
$\Delta_{40\%}$	in	-0.17	-0.19	7.2
	mm	-4.32	-4.79	
Energy Dissipated	kip*ft	-0.29	-0.30	3.8
	kN*m	-0.39	-0.41	
Elastic Stiffness, K_e @0.4 F_{peak}	kip/in	-2.24	-2.20	1.3
	kN/mm	-0.39	-0.39	
Ductility Ratio, μ		10.9	9.1	12.4
Initial Load		25	0	

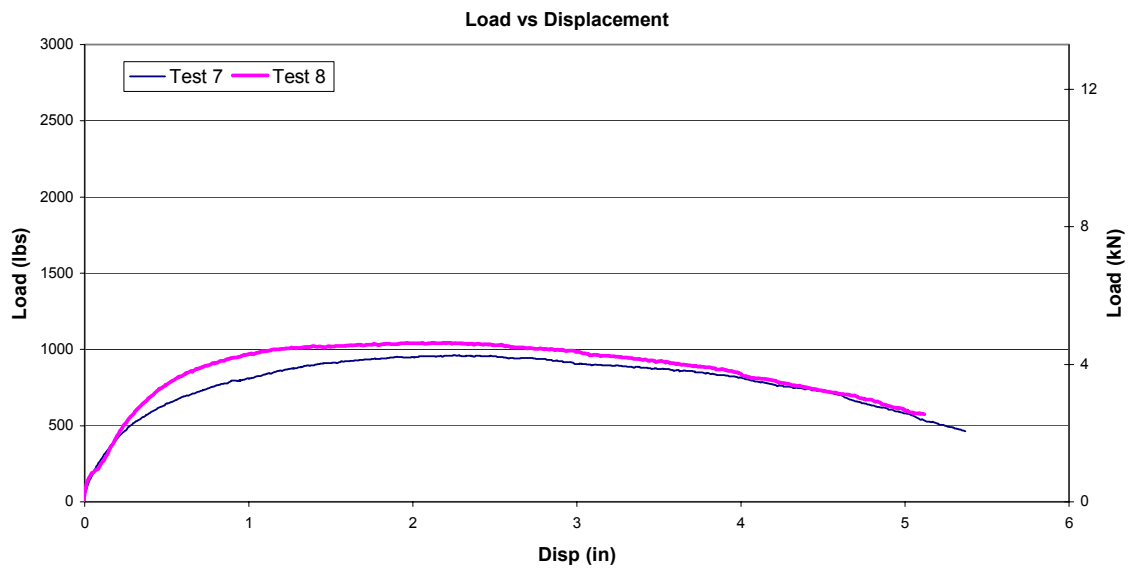


Figure A.13: Load-Displacement curve of gypsum wallboard

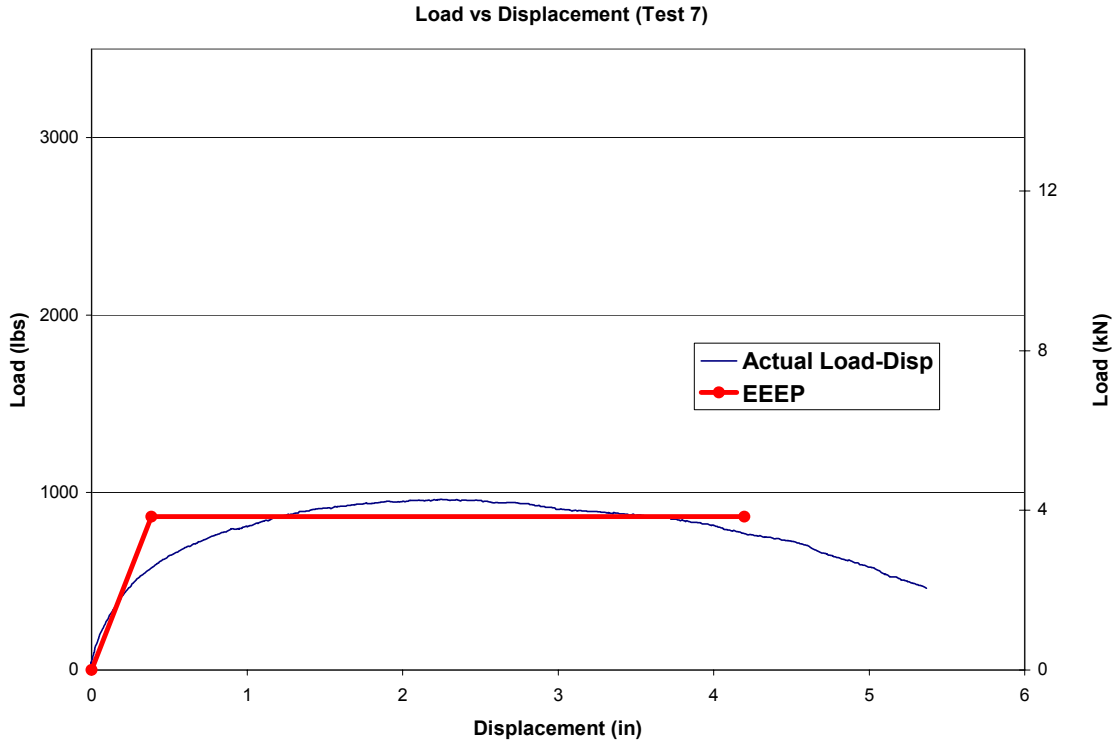


Figure A.14: EEEP curve for Test 7

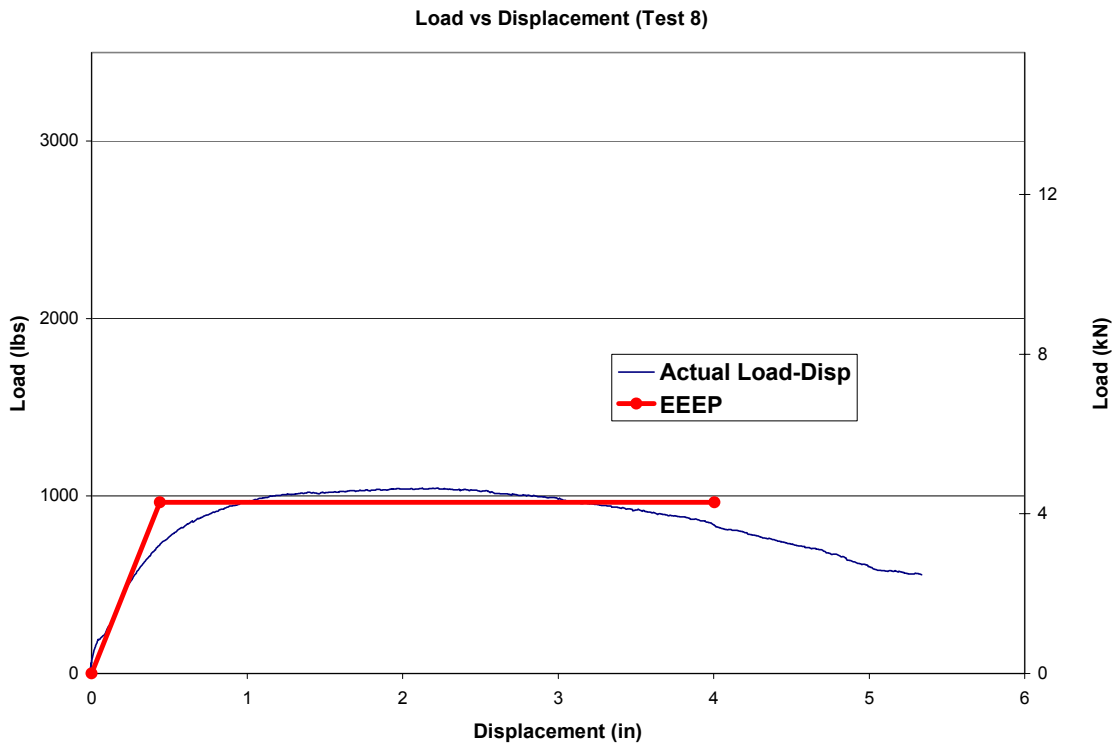


Figure A.15: EEEP curve for Test 8

Test:	25	26
Testing Procedure:	Monotonic	Monotonic
Material:	OSB/GWB	OSB/GWB
Date Constructed:	7/25/02	07/25/02
Date Tested:	7/26/02	7/29/02

Test 25 Observations:

-OSB nails pulled through on the bottom plate near the ram, and on the end studs near the bottom of the wall.

-The gypsum nails behaved in a similar fashion to Test 7 and Test 8.

-Some uplift was noticeable on the right side hold-down.

Test 26 Observations:

-OSB nails pulled through on the bottom plate near the ram, and on the end studs near the bottom of the wall.

-The gypsum nails behaved in a similar fashion to Test 7 and Test 8.

-Some uplift was noticeable on the right side hold-down.

Table A.5: Monotonic analysis results of OSB with gypsum

OSB/Gypsum

		Test 25	Test 26	COV(%)
Max Load, F_{peak}	kip	2.96	3.12	3.7
	kN	13.17	13.88	
Δ_{peak}	in	-2.81	-3.65	18.5
	mm	-71.29	-92.77	
$F_{failure}$ or $0.8F_{peak}$	kip	2.36	2.85	13.3
	kN	10.50	12.68	
$\Delta_{failure}$	in	-4.59	-5.50	12.8
	mm	-116.48	-139.69	
Yield Load, F_{yield}	kip	2.65	2.88	5.8
	kN	11.80	12.81	
Δ_{yield}	in	-0.37	-0.68	42.5
	mm	-9.34	-17.35	
$F_{40\%}$	kip	1176.81	1268.58	5.3
	kN	5234.44	5642.66	
$\Delta_{40\%}$	in	-0.16	-0.30	42.0
	mm	-4.14	-7.64	
Energy Dissipated	kip*ft	-0.97	-1.24	16.9
	kN*m	-1.32	-1.68	
Elastic Stiffness, K_e @0.4 F_{peak}	kip/in	-7.22	-4.22	37.2
	kN/mm	-1.26	-0.74	
Ductility Ratio, μ		12.50	8.05	30.6
Initial Load		510.00	30.00	

Note: Test 26 did not fail

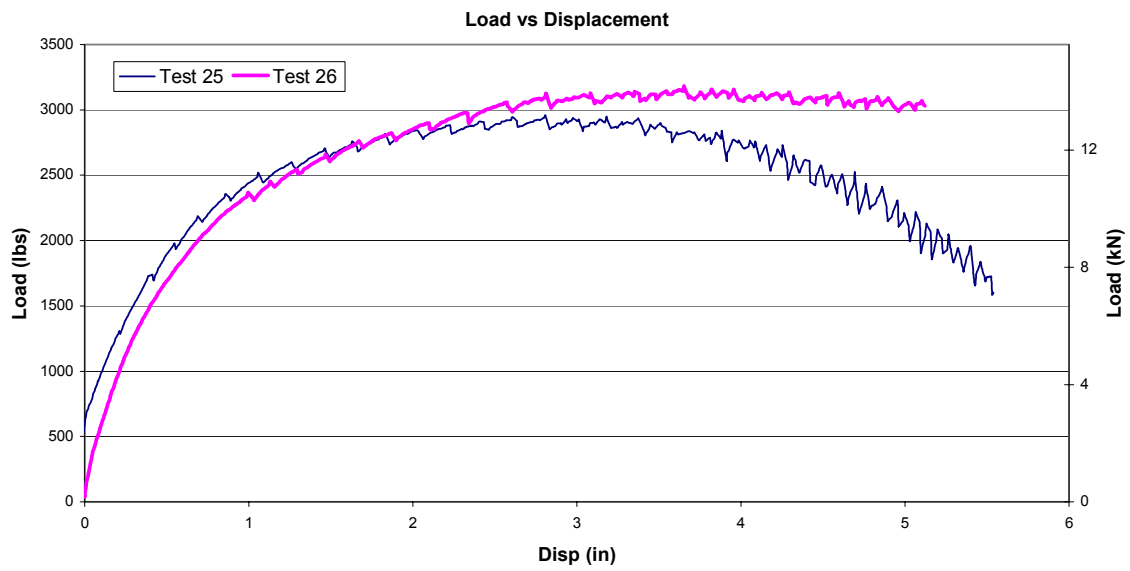


Figure A.16: Load-Displacement curve of OSB with gypsum

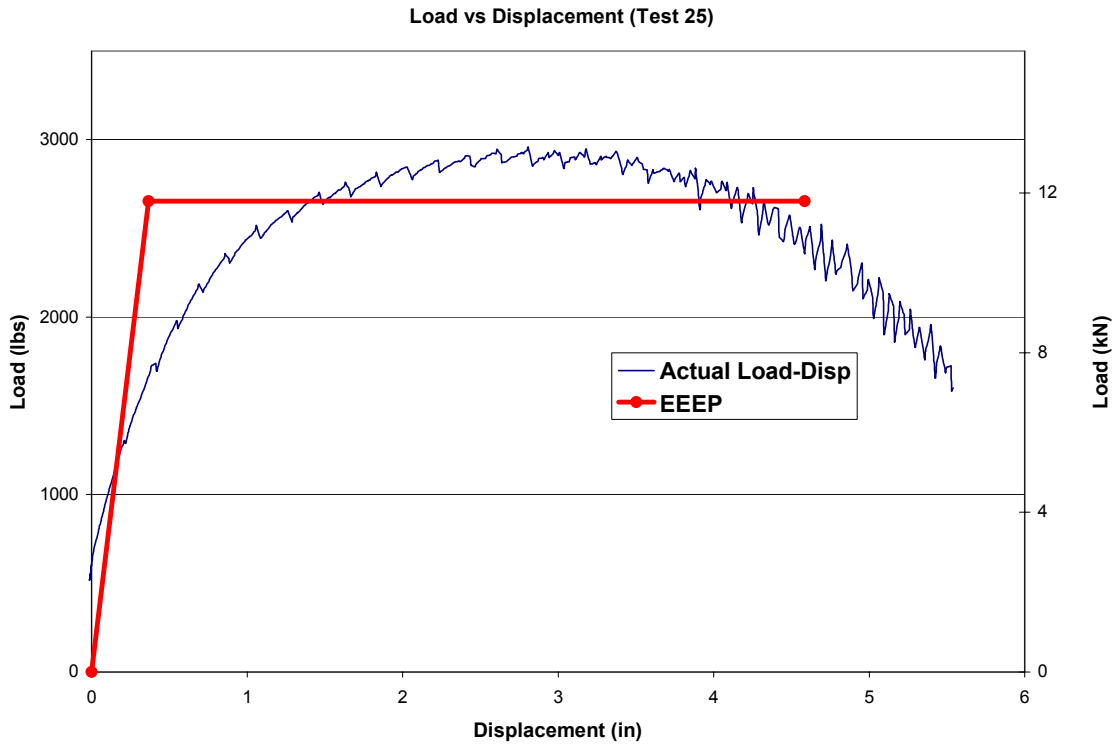


Figure A.17: EEEP curve for Test 25

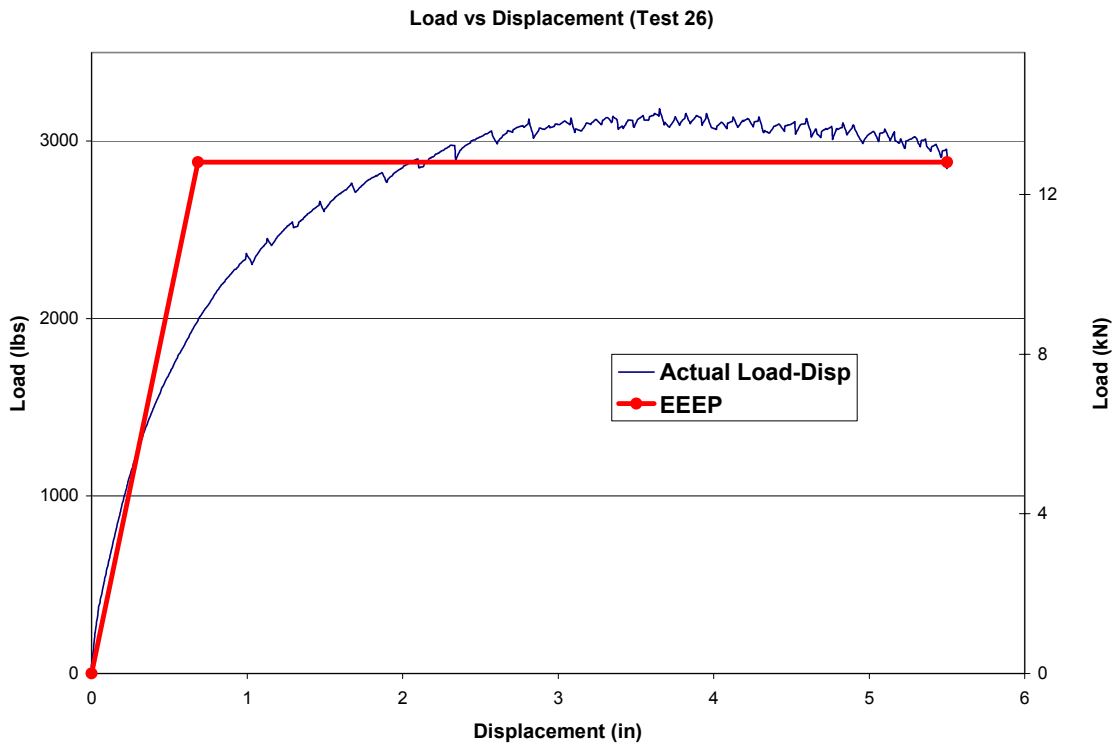


Figure A.18: EEEP curve for Test 26

Test:	27	28
Testing Procedure:	Monotonic	Monotonic
Material:	Hardboard/GWB	Hardboard/GWB
Date Constructed:	7/25/02	07/19/02
Date Tested:	7/29/02	7/29/02

Test 27 Observations:

-Hardboard nails on the bottom plate nearly pulled all of the way out of the framing during the duration of the test. As was typical with the hardboard sheathing, the nails did very little damage to the actual sheathing (nails never ripped through the sheathing).

-Gypsum nails ripped through sheathing on the bottom right and top left corners.

-Mode of failure appeared to be the nails pulling out of the framing.

Test 28 Observations:

-Hardboard nails pulled out of framing nearly all of the way, leaving no damage to the sheathing, as seen in Test 27.

-Gypsum nails ripped through sheathing on the bottom right and top left corners.

-Mode of failure appeared to be the nails pulling out of the framing.

Table A.6: Monotonic analysis results of hardboard with gypsum

Hardboard/Gypsum

		Test 27	Test 28	COV (%)
Max Load, F_{peak}	kips	2.99	2.85	3.4
	kN	13.29	12.67	
Δ_{peak}	in	-1.94	-2.01	2.3
	mm	-49.39	-51.04	
$F_{failure}$ or $0.8F_{peak}$	kips	2.37	2.28	2.8
	kN	10.53	10.12	
$\Delta_{failure}$	in	-5.04	-3.96	17.0
	mm	-128.00	-100.51	
Yield Load, F_{yield}	kips	2.73	2.58	3.9
	kN	12.13	11.48	
Δ_{yield}	in	-0.30	-0.20	29.0
	mm	-7.57	-4.99	
$F_{40\%}$	kips	1.16	1.12	2.6
	kN	5.17	4.99	
$\Delta_{40\%}$	in	-0.13	-0.09	27.9
	mm	-3.23	-2.17	
Energy Dissipated	kip*ft	-1.11	-0.83	20.5
	kN*m	-1.51	-1.13	
Elastic Stiffness, K_e @0.4 F_{peak}	kip/in	-9.14	-13.14	25.4
	kN/mm	-1.60	-2.30	
Ductility Ratio, μ		16.9	20.1	12.4
Initial Load		170	255	

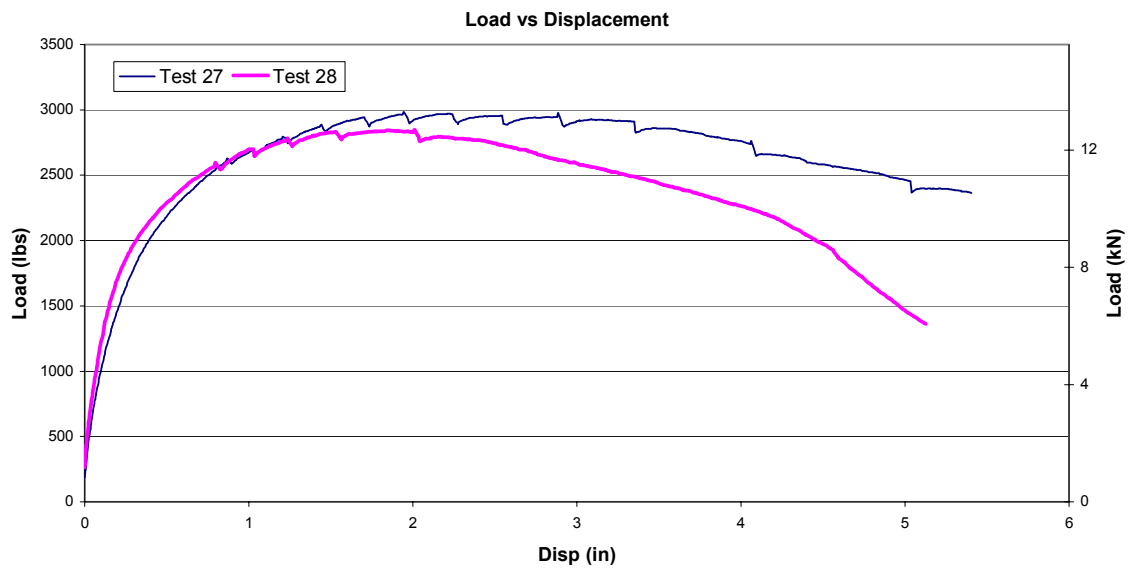


Figure A.19: Load-Displacement graph of hardboard and gypsum

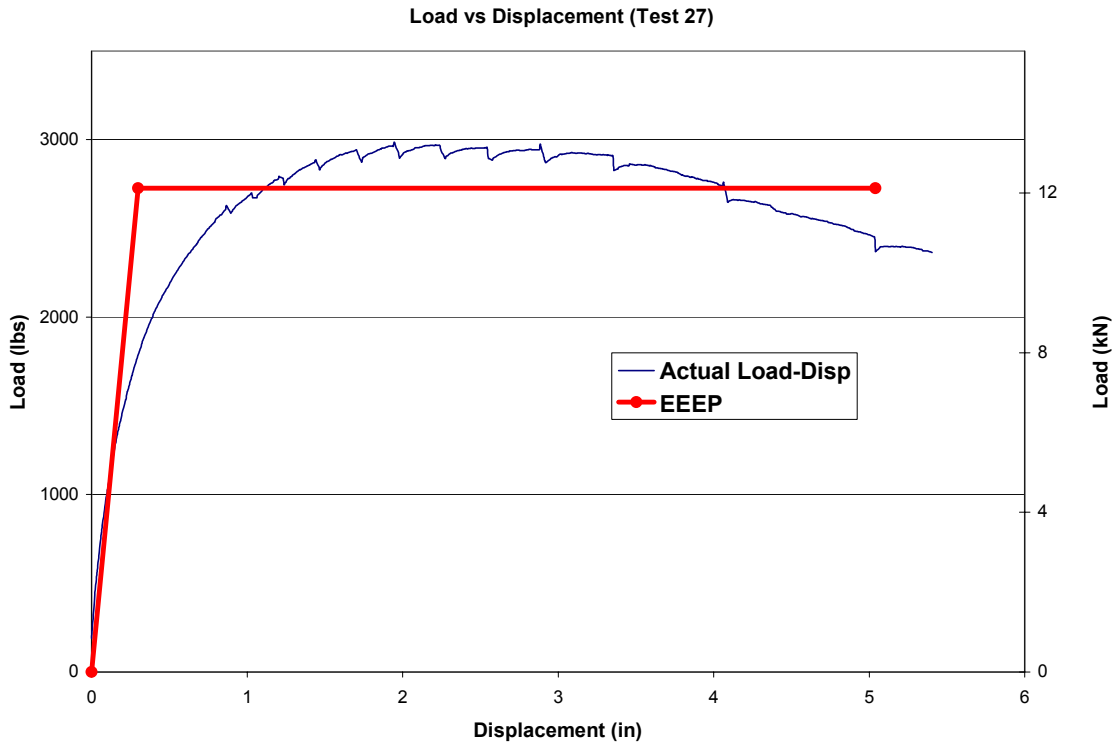


Figure A.20: EEEP curve for Test 27

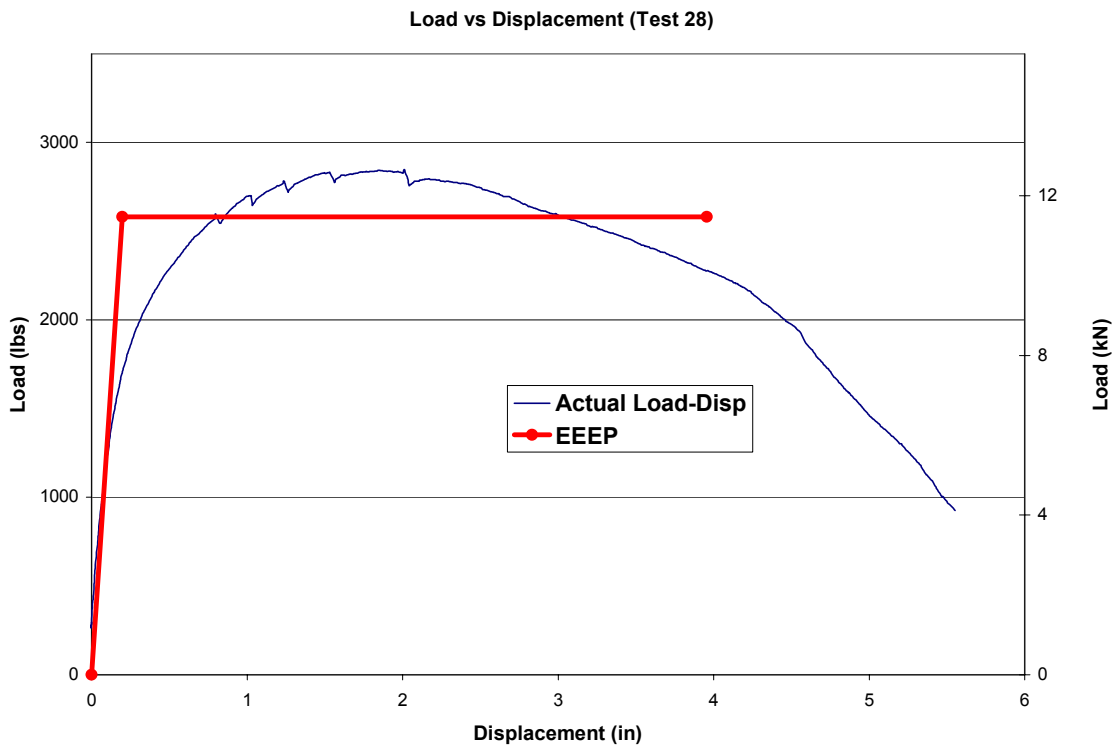


Figure A.21: EEEP curve for Test 28

Test:	29	30
Testing Procedure:	Monotonic	Monotonic
Material:	Fiberboard/GWB	Fiberboard/GWB
Date Constructed:	7/14/02	07/30/02
Date Tested:	7/29/02	7/31/02

Test 29 Observations:

-Fiberboard nails either ripped through sheathing or pulled out of framing along the bottom plate and the end studs near the ram. Other fiberboard nails appeared to have no damage.

-Gypsum nails ripped through sheathing in typical fashion.

-Mode of failure was the sheathing nails pulling out of, or ripping through sheathing, and the right end stud separating from the top plate. Although not seen due to sheathing material on both sides, it was assumed that the 2nd stud also pulled away from the bottom plate as observed in similar tests when the right end stud separated from the top plate.

Test 30 Observations:

-Fiberboard nails either ripped through sheathing or pulled out of framing along the bottom plate and the end studs near the ram. Other fiberboard nails appeared to have no damage.

-Gypsum nails ripped through sheathing in typical fashion.

-Mode of failure was the sheathing nails pulling out of, or ripping through sheathing, and the right end stud separating from the top plate. Although not seen due to sheathing material on both sides, it was assumed that the 2nd stud also pulled away from the bottom plate as observed in similar tests when the right end stud separated from the top plate.

Table A.7: Monotonic analysis results of fiberboard with gypsum

Fiberboard/Gypsum

		Test 29	Test 30	COV (%)
Max Load, F_{peak}	kips	2.35	2.27	2.6
	kN	10.45	10.07	
Δ_{peak}	in	-2.40	-2.82	11.3
	mm	-60.99	-71.54	
$F_{failure}$ or $0.8F_{peak}$	kips	1.79	1.81	0.8
	kN	7.96	8.05	
$\Delta_{failure}$	in	-3.49	-3.83	6.6
	mm	-88.54	-97.19	
Yield Load, F_{yield}	kips	2.11	2.01	3.3
	kN	9.39	8.95	
Δ_{yield}	in	-0.25	-0.50	48.0
	mm	-6.22	-12.62	
$F_{40\%}$	kips	0.94	0.89	3.7
	kN	4.18	3.96	
$\Delta_{40\%}$	in	-0.11	-0.22	47.7
	mm	-2.77	-5.59	
Energy Dissipated	kip*ft	-0.59	-0.60	0.9
	kN*m	-0.80	-0.81	
Elastic Stiffness, K_e @0.4 F_{peak}	kip/in	-8.62	-4.05	51.0
	kN/mm	-1.51	-0.71	
Ductility Ratio, μ		14.2	7.7	41.9
Initial Load		240	38	

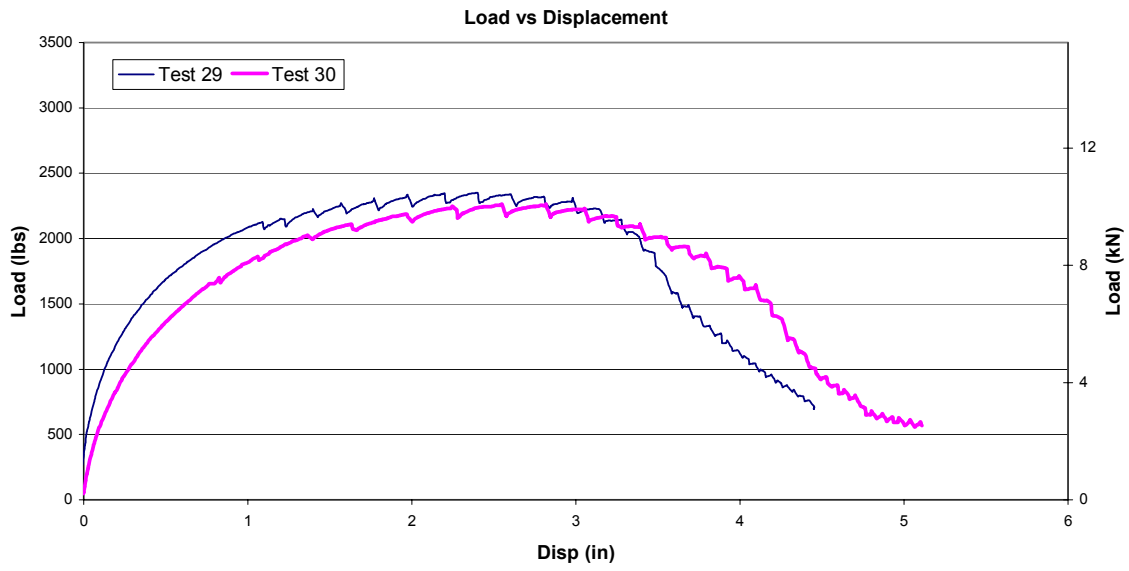


Figure A.22: Load-Displacement curve of fiberboard and gypsum

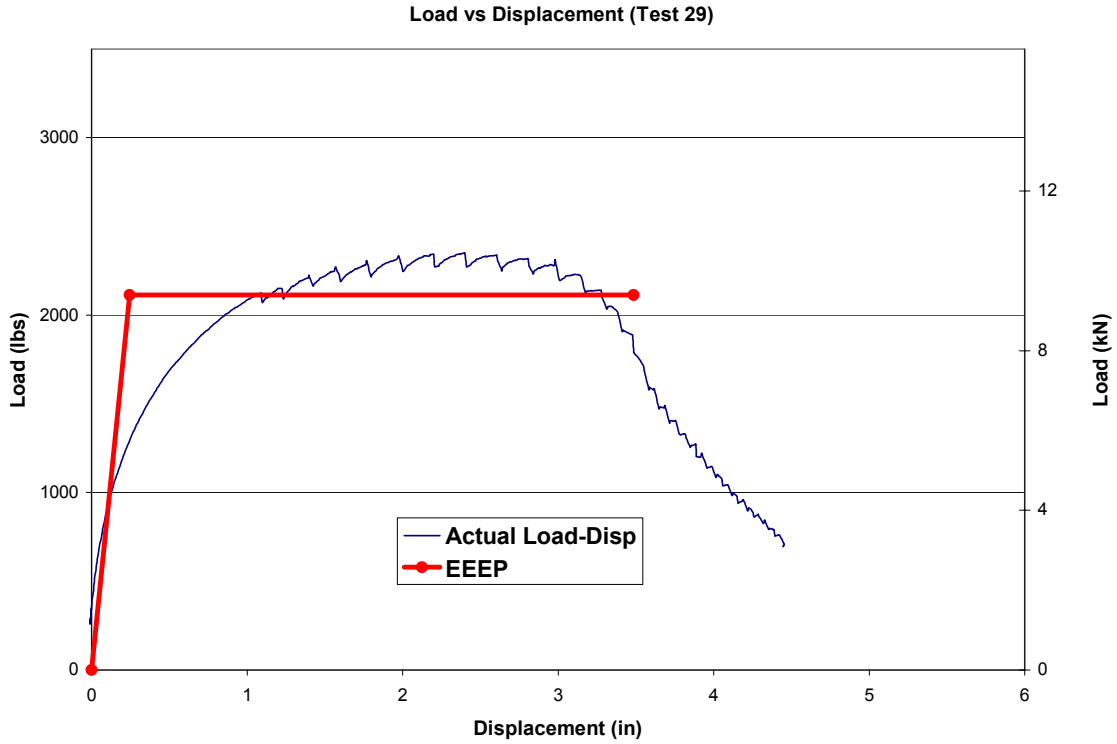


Figure A.23: EEEP curve for Test 29

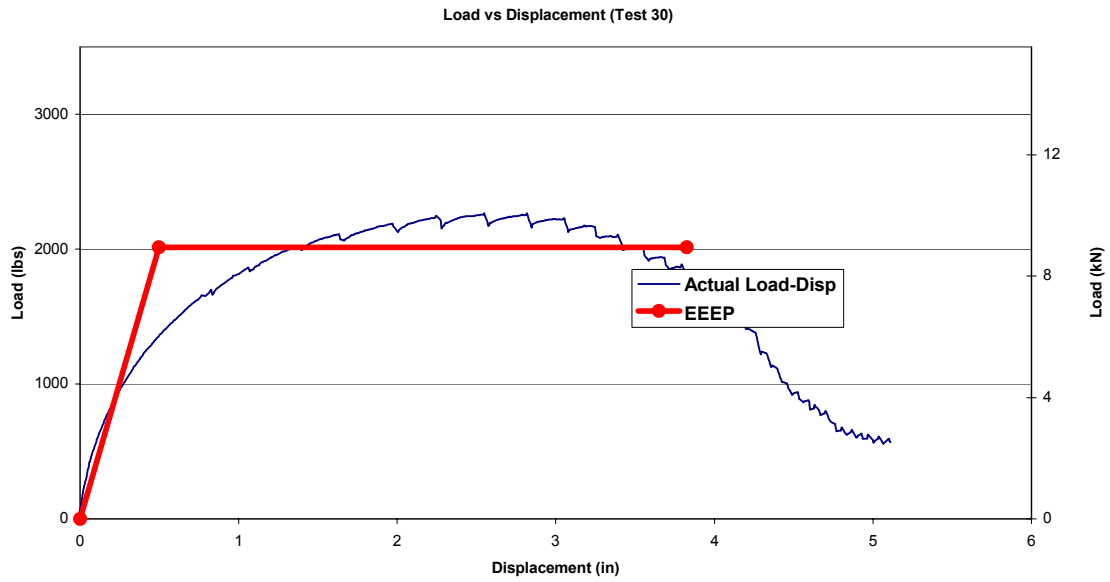


Figure A.24: EEEP curve for Test 30