Engineering Specifications
Metric

Reinforced Concrete Fill	Units	800 Series
Factored Moment Capacities with1, 2 and 4 rebar	See tables 1, 4 and 7 for data.	
Bending Stiffness with1, 2 and 4 rebar	See tables 2, 5 and 8 for data	
Factored Shear Capacities	See tables 3, 6 and 9 for data	

Without Concrete Fill	Units	800 Series
Allowable Moment apparent*	kNm/m	19.7
Allowable Shear**	kN/m	92.1
Section Modulus theoretical apparent*	cm^3/m	1,828.0 892.5
Moment of Inertia I^t theoretical I^a apparent*	cm^4/m	18,573 9,013

General Specifications	Units	800 Series
U-Channel Section Depth	mm	203.2
U-Channel Section Width	mm	304.8
Nominal Thickness****	mm	6.9
Weight	kg/m	10.6
Modulus of Elasticity	MPa	2,620
Tensile Strength	MPa	43.4
Design Strength***	MPa	22.1
Impact Strength	kJ	0.1

Material: Proven, durable co-extruded rigid vinyl material formulated for exterior weatherability and high impact resistance. The outer layer is a UV-resistant virgin vinyl compound. The inner layer is post-industrial recycled vinyl. See page 5 for recycled data.

No warranty of any kind is made as to the suitability of Truline for a particular application or the results obtained there from. Consult a professional engineer.

Notes:

The tables that follow are the recommended values for factored structural moment capacities and corresponding bending stiffnesses of Truline sections filled with reinforced concrete. The tabulated values were computed for a range of concrete compressive strengths and reinforcement options. The factored moment capacities were determined from nonlinear moment vs. curvature behavior computed using LPile 2012 software. The nominal moment capacities were determined when the maximum compressive strain in the concrete ereached .003 in/in. **The reported ultimate (factored) moment capacities were computed by multiplying the nominal moment capacity by a strength reduction factor of 0.65.** The reported bending stiffnesses are for moment levels equal to the ultimate moment capacity and are for cracked sections. This method for determining moment capacities for the Truline/Reinforced Concrete sections was validated by the actual lab test (page 7).

Factored shear capacity is nominal shear capacity of the concrete and the Truline form **reduced by a strength reduction factor of 0.75.**

Per ACI 318-08 Section 11.4.6.1 shear reinforcing steel is not typically required by the Truline system since the section depth is less than 10 inches and the walls typically have shear loads well under 50% of the factored shear capacity without steel. If in the rare case the shear load exceeds this threshold, minimum shear reinforcing steel should be added per ACI 318-08 standard.

* Based on full scale performance test by Architectural Testing, Inc. Report #70174.01-122-44, not theoretical calculations (page 8).

Truline's allowable moment, for applications not filled with reinforced concrete, is based on section properties that were determined using full scale performance testing rather than theoretical calculations. This is a conservative approach that accounts for the viscoelastic behavior of the material that determines its mechanical properties. It results in a value that the design engineer can be confident in without applying excessive factors of safety.

** All pile sections must be filled with gravel or other material such as soil, sand, pebble, etc. to ensure the web is fully supported and the shear load is transferred from flange to flange by the fill material. Shear load must be applied by continuous beam or waler on the face of the wall.

t I (theoretical) is moment of inertia as calculated for the shape and adjusted to a per foot basis.

a I (apparent) is moment of inertia determined experimentally by a full scale test and measuring the deflection of the wall. This is the value for moment of inertia that would predict the deflections that were measured across a range of known loads. This number is also adjusted to a per foot basis.

*** Based on published data by US Army Corps of Engineers Report #ERDC/CRREL LR-03-19

**** For comparative purposes, the total material wall thickness listed should be doubled due to the Truline double wall design.

TABLE 1: 800 Series — Factored Moment Capacities* (Nm/m width of wall) — Reinforced Sections 1 Rebar

Bar Size	Concrete Compressive Strength, f'c psi				
	3,000	**3,500**	**4,000**	**4,500**	**5,000**
No. 4	15,307	15,751	16,085	16,381	16,567
No. 5	15,974	16,530	16,900	17,197	17,456
No. 6	19,384	20,792	21,533	22,089	22,534
No. 7	21,088	23,534	25,610	27,204	28,093
No. 8	22,163	25,054	27,685	30,020	32,096
No. 9	23,090	26,129	29,020	31,725	34,245
No. 10	24,090	27,352	30,391	33,319	36,136
No. 11	25,017	28,464	31,614	34,690	37,655
No. 14	27,129	30,725	34,208	37,581	40,768

** As stated on page 1, the reported ultimate (factored) moment capacities were computed by multiplying the nominal moment capacity by a strength reduction factor of 0.65.*

TABLE 2: 800 Series — Bending Stiffness (Nm^2/m width of wall) — Reinforced Sections 1 Rebar

Bar Size	Concrete Compressive Strength, f'c psi				
	3,000	**3,500**	**4,000**	**4,500**	**5,000**
No. 4	609,646	632,653	651,528	667,492	681,391
No. 5	642,607	667,680	688,434	705,900	721,113
No. 6	764,968	797,742	827,886	853,616	875,966
No. 7	904,796	941,044	974,475	1,005,746	1,036,266
No. 8	1,045,938	1,088,948	1,127,919	1,163,604	1,196,847
No. 9	1,176,469	1,228,118	1,273,569	1,315,546	1,353,578
No. 10	1,320,523	1,381,938	1,437,250	1,486,457	1,531,908
No. 11	1,450,866	1,521,484	1,586,093	1,643,845	1,696,246
No. 14	1,705,918	1,797,572	1,879,459	1,953,645	2,021,916

TABLE 3: 800 Series — Factored Shear Capacity N/m width* — Reinforced Sections 1 Rebar

$V_c + V_F$	Concrete Compressive Strength, f'c psi				
	3,000	**3,500**	**4,000**	**4,500**	**5,000**
N/m	117,050	120,850	124,515	127,880	130,950

**As stated on page 1, the reported factored shear capacities were computed by multiplying the nominal shear capacity by a strength reduction factor of 0.75.*

800 Series — Rebar Placement — Reinforced Sections 1 Rebar

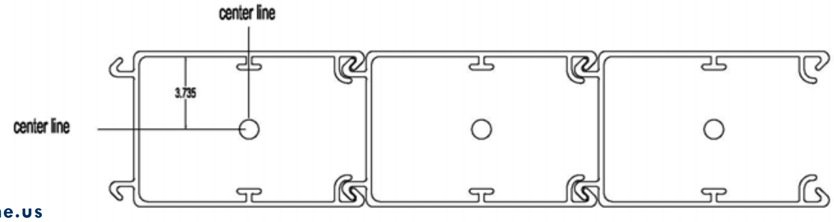


TABLE 4: 800 Series — Factored Moment Capacities* (Nm/m width of wall) — Reinforced Sections 2 Rebar

Bar Size	Concrete Compressive Strength, f'c psi				
	3,000	**3,500**	**4,000**	**4,500**	**5,000**
No. 4	23,905	24,424	24,758	25,017	25,202
No. 5	31,911	32,948	33,727	34,320	34,801
No. 6	38,730	41,510	42,992	44,067	44,956
No. 7	42,177	47,069	51,220	54,333	56,149
No. 8	44,363	50,071	55,334	60,041	64,155
No. 9	46,179	52,295	58,076	63,487	68,528
No. 10	48,144	54,630	60,782	66,675	72,271
No. 11	50,034	56,742	63,228	69,380	75,310
No. 14	54,296	61,486	68,417	75,125	81,574

** As stated on page 1, the reported ultimate (factored) moment capacities were computed by multiplying the nominal moment capacity by a strength reduction factor of 0.65.*

TABLE 5: 800 Series — Bending Stiffness (Nm^2/m width of wall) — Reinforced Sections 2 Rebar

Bar Size	Concrete Compressive Strength, f'c psi				
	3,000	**3,500**	**4,000**	**4,500**	**5,000**
No. 4	1,023,588	1,054,578	1,079,933	1,102,471	1,121,252
No. 5	1,283,711	1,333,482	1,374,801	1,409,547	1,439,597
No. 6	1,528,809	1,594,544	1,654,645	1,705,355	1,750,430
No. 7	1,808,653	1,880,961	1,947,635	2,010,553	2,071,593
No. 8	2,091,313	2,176,769	2,254,712	2,326,081	2,392,755
No. 9	2,352,375	2,455,673	2,546,763	2,630,341	2,706,405
No. 10	2,640,670	2,764,628	2,874,499	2,972,163	3,063,253
No. 11	2,901,732	3,044,471	3,172,185	3,287,691	3,391,928
No. 14	3,411,649	3,594,768	3,759,105	3,907,479	4,043,644

TABLE 6: 800 Series — Factored Shear Capacity N/m width* — Reinforced Sections 2 Rebar

$V_c + V_F$	Concrete Compressive Strength, f'c psi				
	3,000	**3,500**	**4,000**	**4,500**	**5,000**
N/m	117,050	120,850	124,515	127,880	130,950

**As stated on page 1, the reported factored shear capacities were computed by multiplying the nominal shear capacity by a strength reduction factor of 0.75.*

800 Series — Rebar Placement — Reinforced Sections 2 Rebar

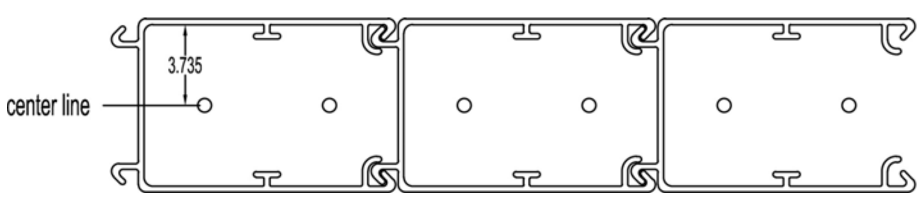


TABLE 7: 800 Series — Factored Moment Capacities* (Nm/m width of wall) — Reinforced Sections 4 Rebar

Bar Size	Concrete Compressive Strength, f'c psi				
	3,000	**3,500**	**4,00**	**4,500**	**5,000**
No. 4	35,543	37,396	38,878	40,064	40,731
No. 5	47,106	49,219	51,183	53,036	54,741
No. 6	59,744	62,227	64,525	66,638	68,676
No. 7	74,717	77,497	80,128	82,574	84,872
No. 8	91,988	95,101	98,029	100,772	103,366

** As stated on page 1, the reported ultimate (factored) moment capacities were computed by multiplying the nominal moment capacity by a strength reduction factor of 0.65.*

TABLE 8: 800 Series — Bending Stiffness (Nm^2/m width of wall) — Reinforced Sections 4 Rebar

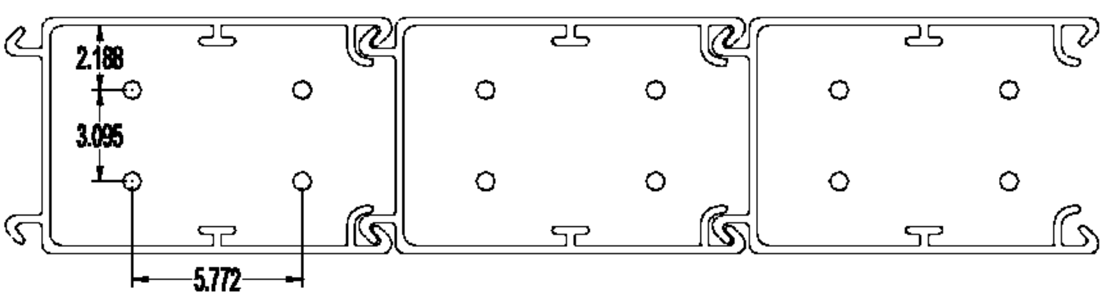
Bar Size	Concrete Compressive Strength, f'c psi				
	3,000	**3,500**	**4,000**	**4,500**	**5,000**
No. 4	2,205,129	2,244,382	2,281,006	2,312,324	2,342,985
No. 5	2,909,104	2,980,633	3,040,480	3,098,938	3,140,257
No. 6	3,596,852	3,701,117	3,799,917	3,878,367	3,944,102
No. 7	4,310,340	4,466,771	4,598,635	4,709,446	4,805,701
No. 8	5,042,817	5,247,675	5,418,380	5,567,467	5,695,472

TABLE 9: 800 Series — Factored Shear Capacity N/m width* — Reinforced Sections 4 Rebar

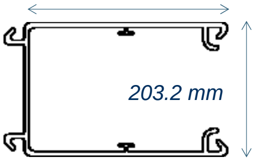
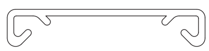
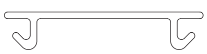
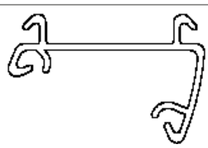
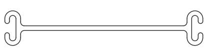
$V_c + V_F$	Concrete Compressive Strength, f'c psi				
	3,000	**3,500**	**4,000**	**4,500**	**5,000**
N/m	117,050	120,850	124,515	127,880	130,950

**As stated on page 1, the reported factored shear capacities were computed by multiplying the nominal shear capacity by a strength reduction factor of 0.75.*

800 Series — Rebar Placement — Reinforced Sections 4 Rebar



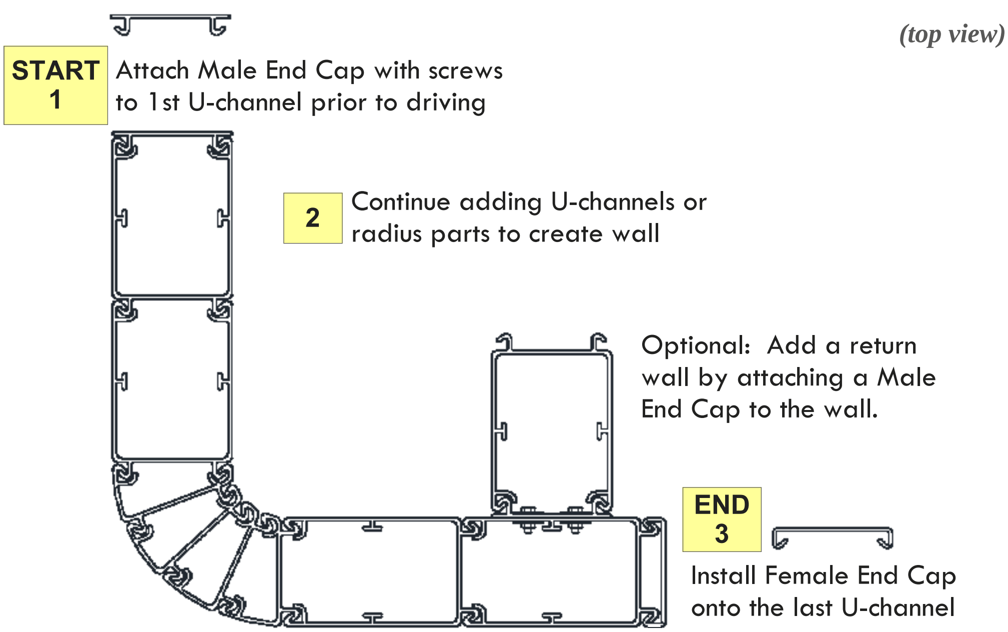
PARTS: 800 Series

Part	Part No.	Name	Recycled Content %
 304.8 mm / 203.2 mm	**800**	**U-Channel** (12" wide x 8" deep) (304.8mm x 203.2mm)	92.5 %
	**801**	**Female End Cap** (Attaches to the last installed u-channel or radius.)	88.7 %
	**802**	**Male End Cap** (Attaches to the first u-channel prior to installation.)	89.8 %
	**803**	**22.5° Radius**	93.3 %
	**804**	**Cross Tie**	98.0 %
	**805**	**5° Radius**	93.5 %

Post-Industrial Recycled Material Content % by Wt. — Installed Mix 92.5%

Note that since the u-channel accounts for the vast majority of pounds used for any given installation, assuming no cross ties are used, the recycled content for the mix of products used in a typical wall is essentially the same as the recycled content of the u-channel itself.

CONFIGURATIONS



COLORS

Three standard colors (below) or a custom color. Colors shown provide only an example and are not exact matches. Sample chips are available upon request.

Light Gray *(GR-01)*

Sand *(SA-02)*

Beige *(BE-03)*

Performed by: Architectural Testing, Inc.—130 Derry Court, York, PA 17406, (717) 764-7700

Report No.: C9598.02-106-31 **Report Date:** 11/10/14
Below is a summary. A full report is available at www.truline.us

Test Project: Perform a simulated seawater spray conditioning and post-exposure abrasion resistance evaluation on reinforced concrete piling specimens protected by Truline against a laboratory-conditioned control specimen and a fully-exposed control specimen consisting of the same reinforced concrete and subjected to the same seawater exposure without the benefit of Truline sheathing.

Test Methods: ASTM G 85-11, ASTM C 1141-98 (2013), and ASTM C 418-12

Test Results Summary: Truline-protected concrete, when exposed to accelerated saltwater testing performed as well as concrete that had no exposure. The test implies that Truline protection may nearly eliminate the damaging effects of saltwater on the surface of the concrete. The life expectancy of Truline-protected concrete is the same as the life expectancy of the same concrete in a non-marine environment. The typical life expectancy for reinforced concrete designed for the long term is 75+ years. Therefore, a properly designed and installed Truline cast-in-place reinforced concrete wall should perform at the same level.

ASTM C 418 - Post-1,000 Hour Salt Fog Exposure Abrasion Resistance

Summary of Results						
Exposure Condition			Abrasion Coefficient (cm^3/cm^2)	Volume Loss ($cm^3/50cm^2$) [1]	Mean Thickness Loss (mm)	Increased Abrasion Resistance Retention vs. Fully Exposed Specimen (%) [2]
Salt Fog	Truline Sheath	Sealed Joints				
Yes	No	N/A	0.20	10.13	2.03	N/A
No	No	N/A	0.16	7.90	1.58	**22.2**
Yes	Yes	No	0.16	7.99	1.60	**21.2**
		Yes	0.16	7.76	1.55	**23.6**

[1] *Volume Loss as presented is converted from the Abrasion Coefficient determined per ASTM C 418, Section 8.4*

[2] *Abrasion Resistance Retention Calculated as follows: ((Exposed Value - Protected Value)/ Exposed Value)*100*

PERFORMANCE TEST SUMMARY

Load Test with Reinforced Concrete

Performed by: Architectural Testing, Inc. — 130 Derry Court, York, PA 17406, (717) 764-7700
Results Analyzed by: Ensoft, Inc. — 3003 W. Howard Lane, Austin, TX 78728, (512) 244-6464

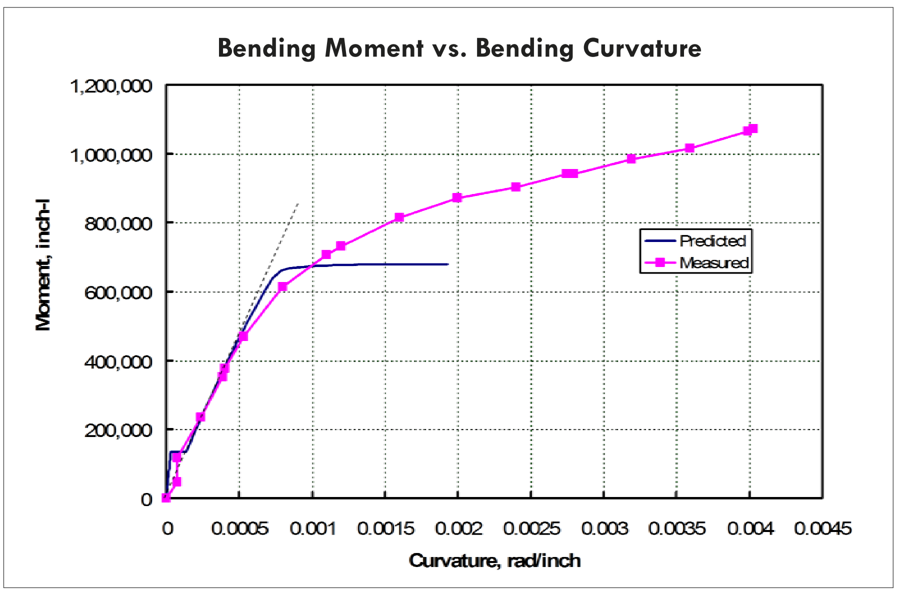
ATI Report No.: B7179.01-122-42 **Report Date:** 6/13/12
Ensoft Report: Interpretation of Testing Results on Truline Composite Sections **Report Date:** 6/6/12
Below is a summary. Full reports are available at www.truline.us

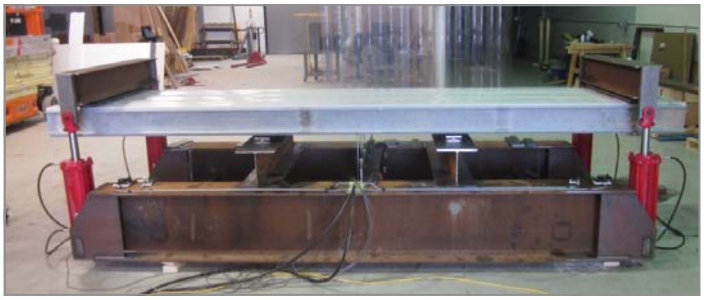
Test Project: Validate predicted performance of Truline filled with reinforced concrete through independent testing and analysis.

Test Procedure: Truline samples measuring 14 ft. long by 3 ft. wide filled with 3000 psi concrete and rebar were placed in 4 point loading ranging from 1000 to 40000 pounds while their center point deflections were measured for the given loads.

Predictions for the test performance for the as-built specimens were made using L-Pile software by computing moment curvature behavior for the material geometries and properties.

Test Results Summary: An analysis showed that the predicted moment-curvature behavior closely matched the observed results. With the computational method validated, it could then be used with confidence to determine the moment capacities for the sections under many variations of concrete strength and reinforcing steel design.





Test setup

8" thick specimen at full cylinder travel

PERFORMANCE TEST SUMMARY
Load Test without Concrete

Performed by: Architectural Testing, Inc. — 130 Derry Court, York, PA 17406, (717) 764-7700

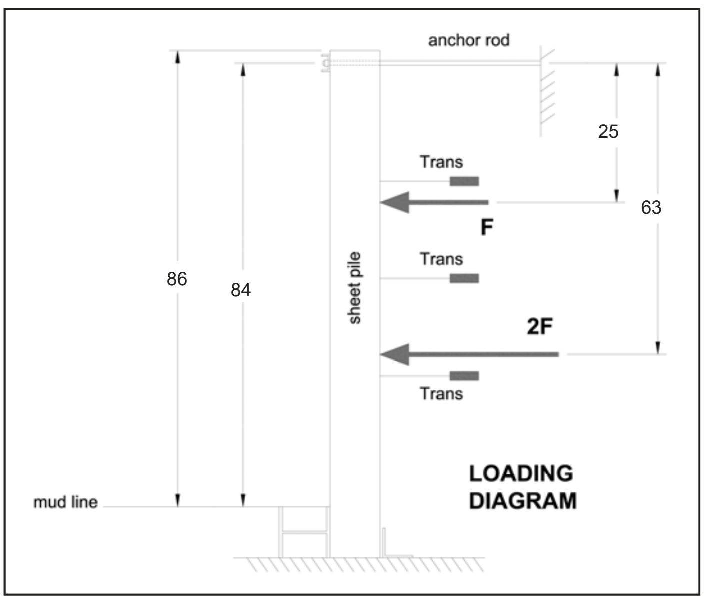
Report No.: 70174.01-122-44 **Report Date:** 2/07
Below is a summary. A full report is available at www.truline.us

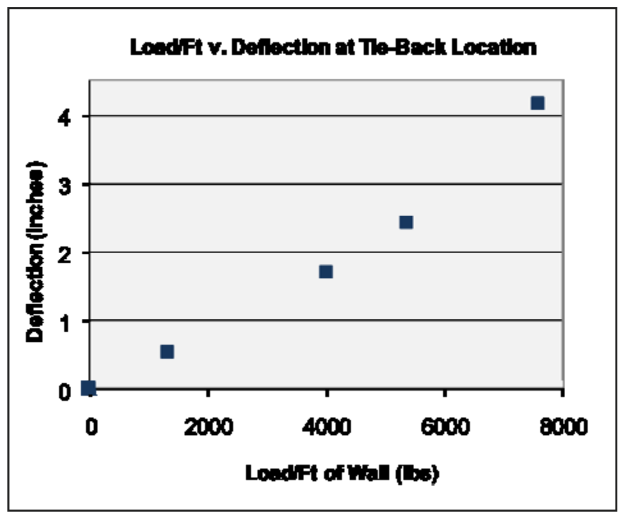

hydraulic cylinders and transducers

Test Project: Test the deflection and hydraulic pressure of Truline.

Test Setup: 8 ft. high Truline wall (7ft. above improvised mud line) with tie-backs, gravel fill and simulated concrete cap. Loading simulation was two rigid steel tubes placed 25in. and 63in. below the top edge. The top tube was loaded with two cylinders and the bottom tube was loaded with four so that the bottom load was always twice the top load. All cylinders were connected to a single manifold and pump so that they all generated equal force. (See Loading Diagram) The wall loaded to the desired level and held for one minute. The pressure was relieved and the wall was allowed to recover for one minute. After four loads were tested, the force on the wall was increased to levels that would exceed forces expected in real applications to observe and record performance data.

Test Results Summary:





Results Summary			
Applied Load per Foot of Wall (Distributed as shown in diagram above)	Max Deflection	Calculated Shear at Mud Line	Calculated Moment (max)
lbs / ft	in	lbs / ft	ft · lbs/ft
1325	0.53	775	1485
4027	1.70	2357	4515
5375	2.42	3146	6028
7599	4.16	4447	8517