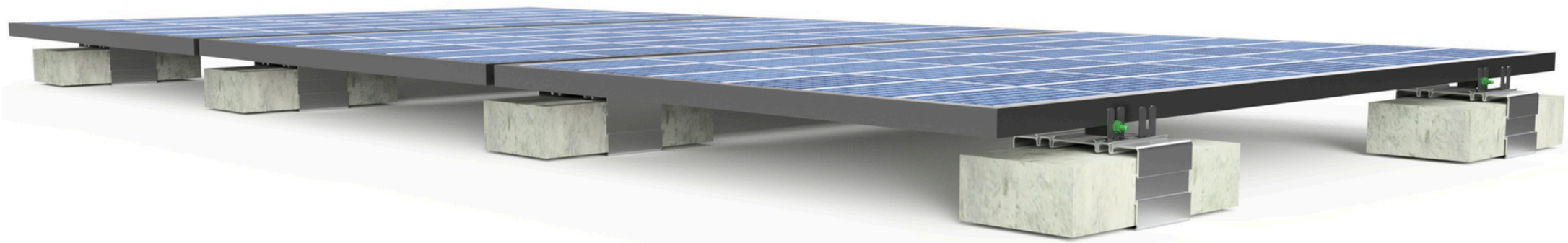
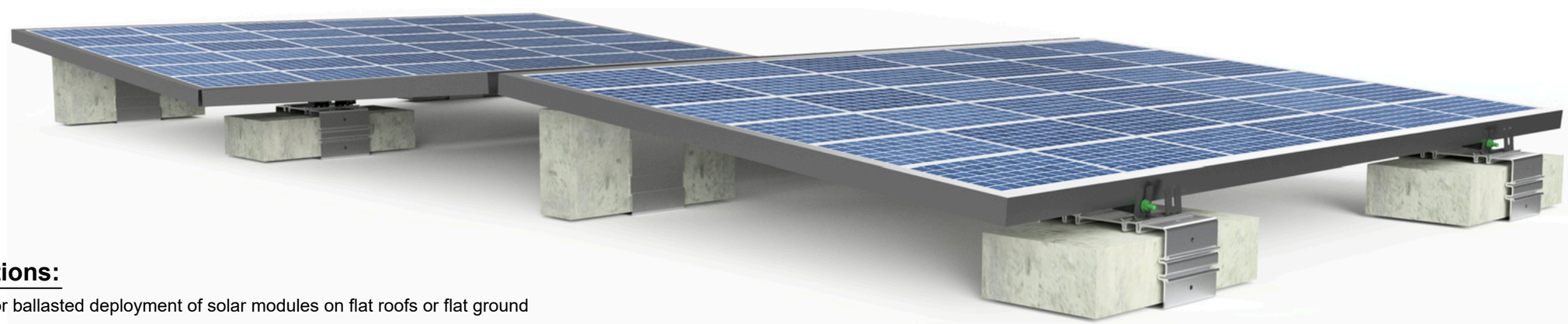
***Data extrapolated from 11-24 Boeing Wind Tunnel testing and mechanical BallastRack hydraulic load testing.**





Specifications:

- Designed for ballasted deployment of solar modules on flat roofs or flat ground scenarios.
- Utilizes standard 32lb CMU cinder blocks (16x8x4")
- Roof material slip sheets (9x6") recommended underneath each base.
- All 'W' configuration systems must start and end row sections with panels angled down. Rows starting or ending with panels angled up must be fully blocked to prevent wind from going under the solar panels.

			PROJECT IntegraRack			
			TITLE IR-W5MBCB MultiBallast Data Sheet 6061 T6 Aluminum			
APPROVED	Paul Budge	09/21/2025	SIZE B	CODE	DWG NO V2-0926	REV
CHECKED	Paul Budge	09/21/2025				
DRAWN	Jeff Glauser	9/20/2025	SCALE 1:10	WEIGHT	SHEET 1/3	

IR-MBW5 Solar Racking System		
	Module size up to 24 sqft	Module size up to 34 sqft
Maximum SnowLoad		
	100psf	65psf
Maximum Wind Speed		
Flat or W Configuration, 20lb CMU	100mph	80mph
Flat or W Configuration, 32lb CMU	140mph	115mph

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Mr. Paul Budge
Diversi-Tech Corp – IntegraRack
PO Box 910758
St. George, UT 84791

Subject: Witness of Wind Tunnel Testing on IntegraRack Products at the George E Boeing Aeronautics Department (Kirsten Wind Tunnel) at the University of Washington

Dear My. Budge,

This letter summarizes the wind tunnel testing that was witnessed at the Kirsten Wind Tunnel (KWT) on November 8th, 2024. Testing took place at KWT on the University of Washington campus at 3900 7th Ave NE, Seattle, WA. Cara Winter was the manager of the facility and testing was performed and overseen by Test Engineers Stuart Dickson and Miguel Salguero. A detailed analysis and calculations of test data is outside the purview of this report and can be provided by KWT personnel.

The wind tunnel data summarized in this report, mechanical material stress testing and solar mount adhesion testing performed by PNL, and simulated wind/snow load model data was extrapolated on product datas sheets by IntegraRack for various product configurations and solar angles for the following IntegraRack solar panel products: TileBallast, BallastRack, BallastRack DR, MultiBallast, MultiBallast DB, H Module Brack, and the IR-F2 Bonding Clamp.

A total of 8 runs were performed on IntegraRack products. Test Runs 1 through 3 were performed with the IR-D1 bracket (See Figures 1-4) with an installed 18 SF solar panel on a simulated roof incline. Run 1 was performed to tare KWT's system through the full 0 to 110 degree rotation of the test platform with the simulated roof and panel installed. The roof surface had been installed at an approximate 5 – 6 degree incline (See Figure 1). The solar panel was mounted at 0 degrees relative to the roof surface with a general height of 5 in from the roof surface. at all four corners of the panel. Test Runs 4 and 5 were performed on the same panel and bracket with the panel height adjusted and installed at an angle with the front corners set to 3-1/2 in. and the back corners set to a height of 6 in. from the roof surface.

Test Runs 2 through 5 included rotating the test setup from 0 to 110 degrees while KWT instrumentation recorded test data. Wind speed was increased until limitations of KWT instrumentation prevented it from being increased further. Four load cells, Omega model LC103B-250 lb Class N10, were installed between the IntegraRack bracket and the roof surface to monitor and record loads applied to the brackets throughout testing (See Figures 5-10). The load cells were labeled LC0-1, LC0-2, LC5-3, and LC5-4 with LC0 being installed at the leading edge and LC5 being installed at the back edge.

The maximum load at a bracket recorded during Test Runs 2 and 3 was 75.015 lbf at a wind speed of 157.67 MPH when the panel was at a rotation point of 60 degrees. No damage or deformation was noted

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to any bracket during or after the test runs and all hardware was found to be secure upon completion of each test (See Figures 11-13).

Test Runs 6 through 8 were performed on the IR Ballast Racks (See Figures 14-32). The simulated roof structure was removed and the frames and panel were mounted directly to the KWT test platform. These runs were performed at a set angle with no platform rotation during the test run. Two load cells were used for the test setups and were mounted at the brackets at the leading edge of the test platform at the wind intake side.

Run 6 was performed on the IR18C with the solar panel at an approximate 18 degree angle (Figures 24-25). The maximum load at a bracket recorded during Test Run 6 was 168.59 lbf at a wind speed of 101.59 MPH. Runs 7 and 8 were performed on the IR30C with the solar panel at a 30 degree angle (Figures 30-32) with Run 7 having the solar panel mounted and aligned with the wind direction to produce maximum forces on the frame and Run 8 being run in an orientation 90 degrees offset from Run 7. The maximum load at a bracket was during Test Run 7 and was 183.38 lbf at a wind speed of 81.138 MPH. Run 7 was stopped when the drag limit of the KWT test apparatus was reached. The solar frame experienced shaking under wind load but no damage was found to any part and all bolts were found to still be tight and in place after the test run. Run 8 was pitch limited by the KWT test apparatus. Similar to Run 7 the frame and solar panel had experienced shaking under load but no damage to the frame or panel was noted and all bolts and connections remained tight.

Test data tables provided by KWT and photos of testing throughout the Test Runs have been attached.

Respectfully submitted,
PHOENIX NATIONAL LABORATORIES, LLC

Kyle Fleege, P.E.
Project Manager / Mechanical Engineer
Phoenix National Laboratories
Ph: 1.602.431.8887
kyle@pnltest.com
www.pnltest.com

Registered Professional Engineer (Mechanical)
CERTIFICATE NO.
53776
KYLE J.
FLEEGE
DATE SIGNED
11-4-2025
ARIZONA U.S.A.
Expires 09/30/2027

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Test data tables provided by Kirsten Wind Tunnel tests are shown below:

RUN	TEST	TP	PSI	QA	QC	SPEEDMPH	LC0-1	LC0-2	LC5-3	LC5-4	DB	LB
2	2379	3	0.0001	16.775	17.799	84.38	1.1732	0.9254	12.114	13.537	0	0
2	2379	4	9.9998	16.676	17.693	84.13	3.3832	0.1309	13.25	12.918	0	0
2	2379	5	20	16.788	17.813	84.414	6.5054	-1.2426	14.882	15.703	0	0
2	2379	6	30	14.846	15.752	79.391	8.6943	-2.5876	11.917	15.932	0	0
2	2379	7	40	15.216	16.144	80.374	10.566	-3.614	9.2887	17.334	0	0
2	2379	8	50	15.91	16.881	82.19	12.154	-4.7729	5.8138	18.225	0	0
2	2379	9	60	17.543	18.614	86.311	15.831	-4.7168	3.432	19.871	0	0
2	2379	10	70	18.075	19.177	87.609	15.929	-2.9647	1.6713	17.613	0	0
2	2379	11	80	19.807	21.015	91.718	16.576	-0.2715	1.6043	16.188	0	0
2	2379	12	90	26.487	28.103	106.081	20.349	2.4846	2.6014	20.856	0	0
2	2379	13	100	27.443	29.117	107.995	23.246	3.9239	1.6397	26.417	0	0
2	2379	14	110	28.046	29.758	109.19	30.304	4.9443	0.4954	31.084	0	0

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RUN	TEST	TP	PSI	QA	QC	SPEEDMPH	LC0-1	LC0-2	LC5-3	LC5-4	DB	LB
3	2379	2	-0.0001	46.765	49.618	141.561	1.1642	2.3972	36.627	39.938	0	0
3	2379	3	10	47.13	50.006	142.153	7.9853	-0.2581	42.362	39.215	0	0
3	2379	4	20	48.375	51.327	144.054	17.809	-5.1282	48.033	50.868	0	0
3	2379	5	30	50.382	53.456	147.043	28.671	-12.013	46.107	61.281	0	0
3	2379	6	40	52.966	56.198	150.773	36.485	-22.577	33.65	68.344	0	0
3	2379	7	50	54.38	57.698	152.791	44.03	-28.356	17.304	72.349	0	0
3	2379	8	60	57.878	61.409	157.674	56.195	-27.306	4.63	75.015	0	0
3	2379	9	70	56.226	59.656	155.402	54.153	-16	-2.0357	62.293	0	0
3	2379	10	80	53.778	57.059	151.975	48.502	-4.0685	-2.0692	49.307	0	0
3	2379	11	90	57.92	61.454	157.771	47.213	3.5417	-0.5077	50.257	0	0
3	2379	12	100	54.454	57.777	152.979	46.905	6.1752	-4.2226	55.18	0	0
3	2379	13	110	36.199	38.408	124.779	34.937	5.9472	-9.3307	38.454	0	0

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Test data tables provided by Kirsten Wind Tunnel tests are shown below:

RUN	TEST	TP	PSI	QA	QC	SPEEDMPH	LC0-1	LC0-2	LC5-3	LC5-4	DB	LB
5	2379	3	0.0003	14.845	15.03	77.742	43.468	45.917	33.192	35.332	0	0
5	2379	4	10	14.115	14.291	75.806	39.406	45.863	32.548	33.352	0	0
5	2379	5	20	14.301	14.479	76.302	41.216	49.171	36.107	33.865	0	0
5	2379	6	30	15.476	15.669	79.377	43.323	49.791	40.199	30.547	0	0
5	2379	7	40	15.792	15.989	80.181	40.37	44.513	37.812	28.348	0	0
5	2379	8	50	15.441	15.633	79.284	34.815	34.07	29.669	27.254	0	0
5	2379	9	60	14.604	14.787	77.107	25.852	21.071	18.666	23.403	0	0
5	2379	10	70	15.452	15.644	79.315	19.532	11.214	10.48	19.561	0	0
5	2379	11	80	15.788	15.985	80.173	13.097	5.1532	4.4544	14.183	0	0
5	2379	12	90	15.937	16.136	80.55	10.261	2.0128	0.5043	11.748	0	0
5	2379	13	100	14.945	15.131	77.998	9.7597	-1.4293	-4.2425	10.805	0	0
5	2379	14	110	15.231	15.421	78.745	10.539	-5.6497	-13.113	8.2362	0	0

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Test data tables provided by Kirsten Wind Tunnel tests are shown below. Blockage corrections to calculate DB and LB ARE APPROXIMATION and were provided by KWT Test Engineers using a simplified version of Shindo's method, outlined in "Simplified Tunnel Correction Method" by Shojiro Shindo, American Institute of Aeronautics and Astronautics, Inc.< Washington DC, 1994: Journal of Aircraft Volume 32, Number 1, Pages 210-213. LB is the lift value and DB is the drag value after wind-off zero values have been subtracted.

RUN	TEST	TP	PSI	QA	QC	SPEEDMPH	LC0-1	LC0-2	LC5-3	LC5-4	DB	LB
6	2379	2	-0.0006	19.964	25.663	101.585	-206.622	-168.586	0.6796	0	244.379	363.911
6	2379	3	-0.0005	19.922	25.611	101.499	-206.361	-167.906	0.5212	0.0001	243.946	363.13
6	2379	4	-0.0005	18.132	23.265	96.748	-185.481	-146.788	-0.5698	0	220.212	326.42
6	2379	5	-0.0004	14.927	19.087	87.632	-146.747	-110.624	1.6089	0	178.639	262.798
6	2379	6	-0.0004	10.021	12.738	71.584	-89.117	-53.252	1.1724	-0.0001	116.858	169.83

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RUN	TEST	TP	PSI	QA	QC	SPEEDMPH	LC0-1	LC0-2	LC5-3	LC5-4	DB	LB
7	2379	2	-0.0001	10.101	16.001	80.229	-165.145	-179.17	-0.0654	0	239.012	297.932
7	2379	3	0	10.304	16.363	81.138	-170.329	-183.382	1.6992	0	245.281	304.603
7	2379	4	0	4.9808	7.7789	55.942	-70.106	-82.668	1.1755	0	113.803	142.75

RUN	TEST	TP	PSI	QA	QC	SPEEDMPH	LC0-1	LC0-2	LC5-3	LC5-4	DB	LB
8	2379	2	90.001	10.165	11.329	67.503	-1.1756	-7.5189	-1.3941	0	51.808	28.96
8	2379	3	90	15.002	16.716	81.993	-13.771	-17.132	0.1391	0	76.302	40.688
8	2379	4	90	17.966	20.011	89.723	-21.883	-23.854	0.307	0	91.033	50.149
8	2379	5	90	24.873	27.701	105.599	-45.078	-38.33	-0.174	0	125.875	68.707
8	2379	6	90	27.029	30.099	110.103	-53.423	-43.1	0.5537	0	136.673	76.038
8	2379	7	90	31.751	35.352	119.364	-71.986	-54.265	-0.7512	0	160.314	91.156
8	2379	8	90	39.784	44.294	133.708	-102.541	-76.2	0.5756	0	200.798	112.886

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PHOTOS

Figure 1: Run 1 through 3 simulated roof setup

Figure 2: Run 1 through 3 setup with panel

Figure 3: Bracket at leading edge LC0-1, LC0-2

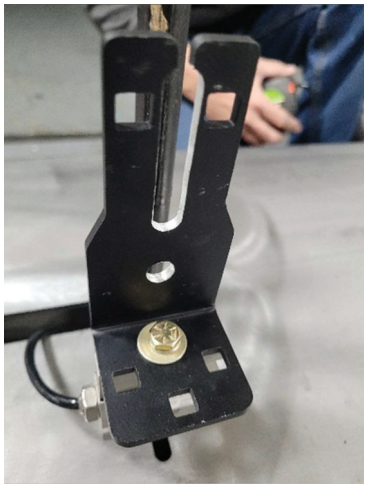

Figure 4: Bracket at back edge LC5-3, LC5-4

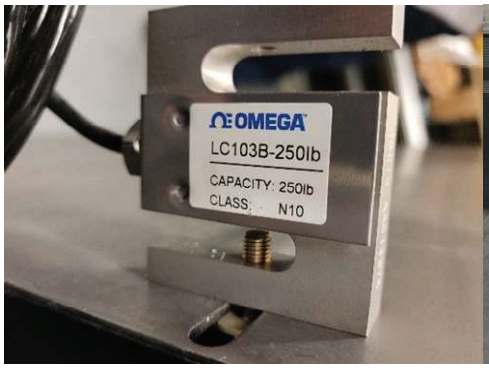

Figure 5: Load Cell Model used for tests

Figure 6: Height from roof to panel, Runs 2 & 3

Figure 7: LC0-1 Location

Figure 8: LC0-2 Location

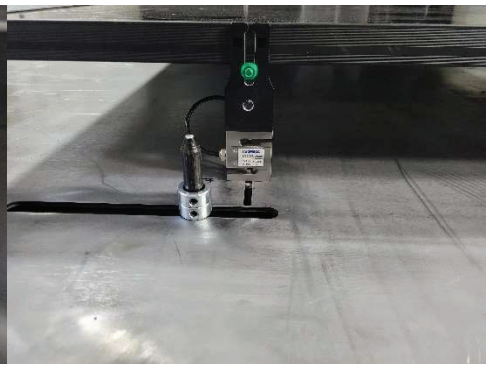

Figure 9: LC5-3 Location

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PHOTOS

Figure 10: LC5-4 Location

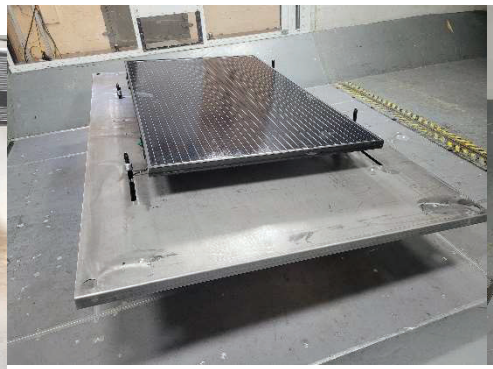

Figure 11: Setup after Run 2, 109 mph winds. No damages or loose hardware noted.

Figure 12: Setup after Run 2, 109 mph winds. No damages or loose hardware noted

Figure 13: Setup after Run 2, 109 mph winds. No damages or loose hardware noted

Figure 14: Setup for Run 6 with IR Ballast Frame

Figure 15: Load cell location at leading edge, LC0-1 & LC0-2

Figure 16: Test setup for Run 6

Figure 17: IR Ballast frame connection to solar panel

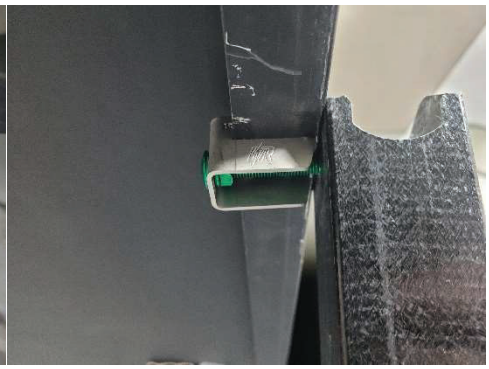

Figure 18: IR Ballast frame connection to solar panel

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PHOTOS

Figure 19: Test setup for Run 6

Figure 20: Solar panels total length, Run 6 through 8

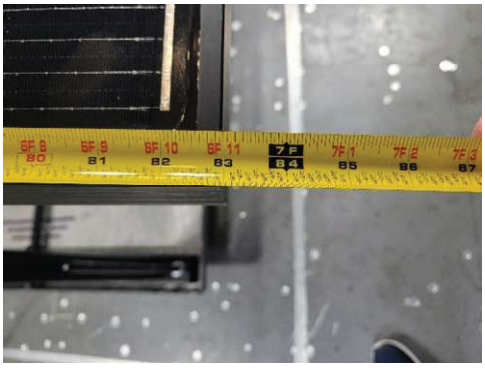

Figure 21: Solar panels total length 83 in.

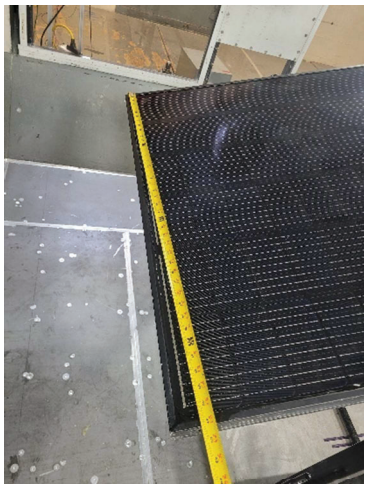

Figure 22: Solar panels width, Run 6 through 8

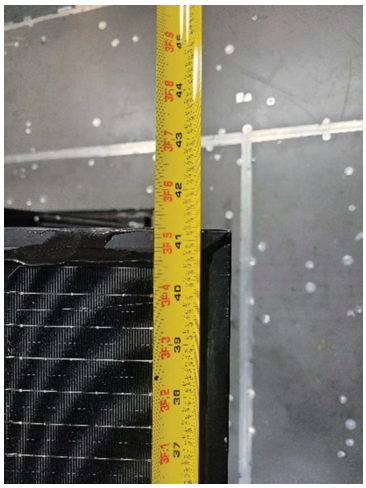

Figure 23: Total width 41-1/4 in.

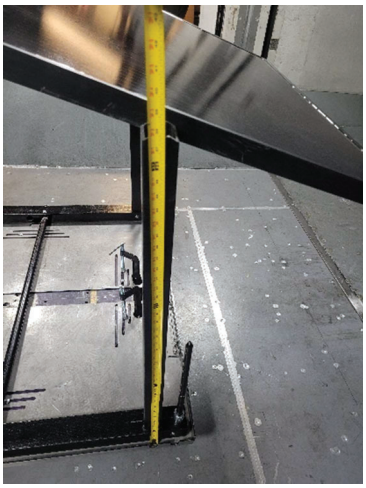

Figure 24: Run 6 trailing edge leg height

Figure 25: Run 6 leading edge leg height

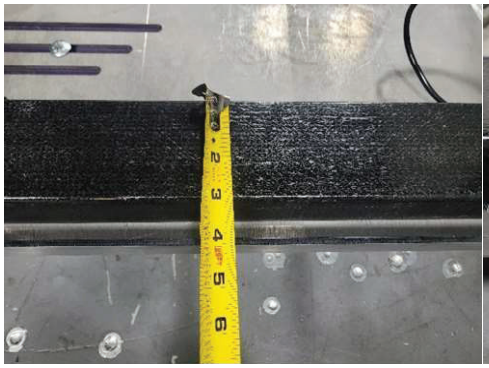

Figure 26: Frame base support width

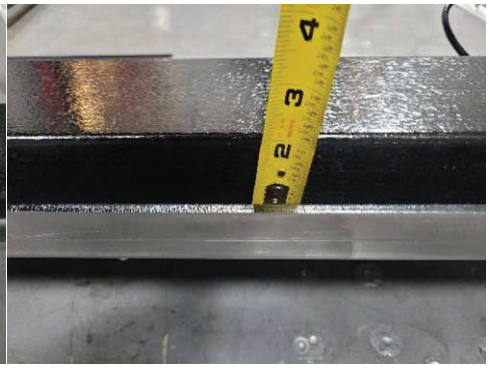

Figure 27: Frame base support height

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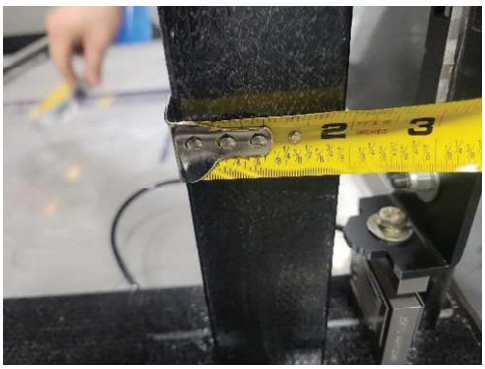

Figure 28: IR Ballast rack leg width 1

Figure 29: IR Ballast rack leg width 2

Figure 30: Runs 7 - 8 Test setup

Figure 31: Run 7 trailing edge leg height

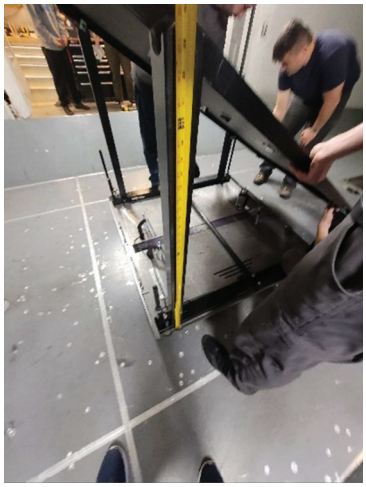

Figure 32: Run 7 Leading edge leg height

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PRELIMINARY LABORATORY TEST REPORT

PNL REF. # 26-251512 **S.O. #** 001 **INDEX** 04

CLIENT	PROJECT/TEST DESCRIPTION	CLIENT ORDER NO.
Diversi-Tech Corporation	Multiballast to Concrete Block Load Test	per S.A.

PNL PROJECT NO.	S.O. NO.	TEST DATE	REPORT DATE
26-251512	001	10/13/2025	10/15/2025

TEST CONDITIONS & EQUIPMENT INFORMATION

Temperature:	73 °F ± 5 °F	**Humidity:**	50 % ± 5 %
Equipment Model:	Instron 5989 UTM	**Serial Number:**	B22667
Load Cell:	100 kN (22,481 lbf) [S/N: 158544]	**Test Speed:**	2 in/min

TEST SPECIMEN INFORMATION

Test Specimen 1:	Multiballast DB	**Dimensions:**	~ 1-3/8 in. x 11-3/4 in. x 4-3/4 in.
Test Specimen 2:	Concrete Block	**Dimensions:**	3-1/2 in. x 7-1/2 in. x 15-1/2 in.
Test Specimen 3:	H-Module Bracket	**Dimensions:**	~ 2-1/2 in. x 3-1/4 in. x 1 in.
Test Specimen 4:	8°, 13°, 20° Riser Mount	**Dimensions:**	~ 5-3/4 in. x 5-1/2 in. x 3-3/16 in.

Test Summary: Multiballast DB to Concrete Block

The Multiballast was installed on the concrete block by sliding the mounting bracket over the block. On the wide side of the block, there was a H-module bracket installed on one of the slide rails, and a 8°, 13°, 20° riser mount with a H-module bracket installed on top of that on the other rail. Test specimen was provided to us assembled by the client (photo 1). The test assembly was then clamped to the table of our universal test machine (UTM) plywood to give adequate clamping force without prematurely damaging the assembly (photo 2).

The UTM was then bolted to the H-module bracket which was installed the riser mount installed on the Multiballast base mount using the designed slide rails for installation. Using only 1 of the 2 mounting holes on the H-module the UTM was bolted to the H-module bracket (photo 3) and applied a compressive force pushing straight down on the bracket at a speed of 2 in/min. Compressive testing was done using the same method on the other H-module bracket without the riser mount (photo 5), and a 3rd test was done on the side of the assembly using a steel block about the same width as the H-module bracket to apply load directly through the Multiballast and block (photo 9).

COMPRESSION LOAD TEST DATA

Test No.	Test Specimen	Displacement at Maximum Load (lbf)	Maximum Load (in.)	Observations
1	Multiballast to concrete block with riser mount and H-module bracket (Photo 1)	0.775	535	8°, 13°, 20° Multiballast riser bracket started deforming and test stopped, minor deformation @ ~430 lbf and major deformation @ ~520 lbf
2	Multiballast to concrete block with H-module bracket (Photo 5)	0.185	2,750	Test manually stopped @ 2000 lbf, minor deformation noted in H-module bracket.
3	Multiballast to concrete block (Photo 9)	0.099	2,371	Test manually stopped @ 2000 lbf, no deformation was noted.

TECHNICIAN_____ REVIEWED BY_____

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LABORATORY TEST REPORT

PNL REF. # 26-251512 **S.O. #** 001 **INDEX** 04

CLIENT	PROJECT/TEST DESCRIPTION		CLIENT ORDER NO.
Diversi-Tech Corporation	Multiballast DB to Concrete Block Load Test		per S.A.
PNL PROJECT NO.	S.O. NO.	TEST DATE	REPORT DATE
26-251512	001	10/13/2025	10/15/2025

TEST GRAPHS

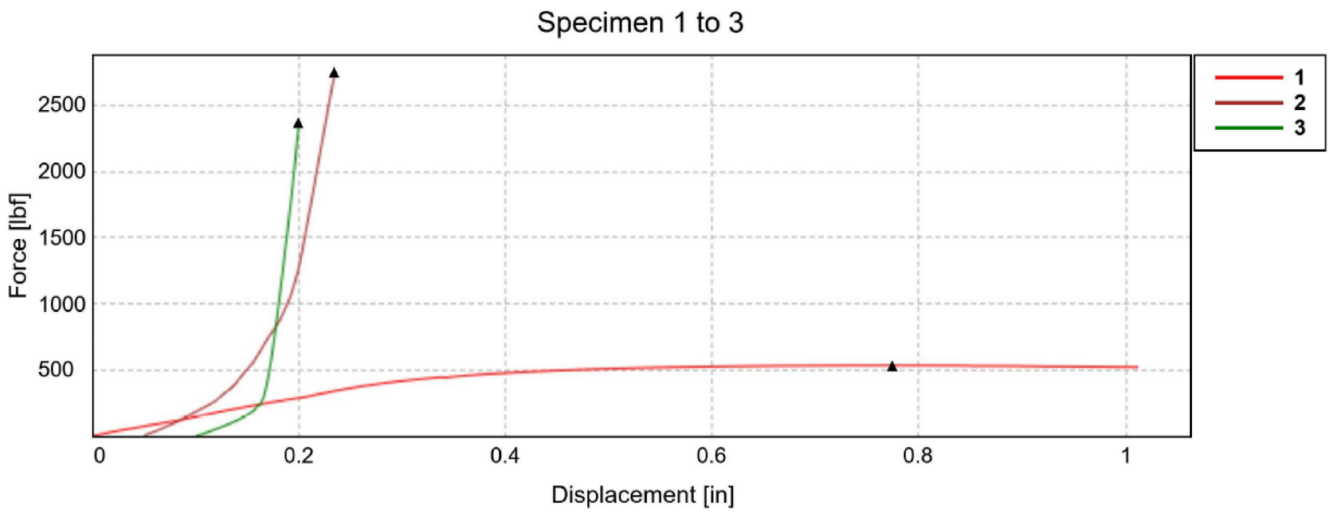

Figure 1: Compressive Force vs Displacement test graph

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PHOTOS

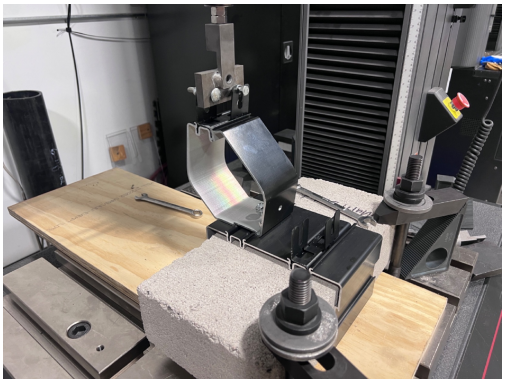

Photo 1: Compression test, setup #1

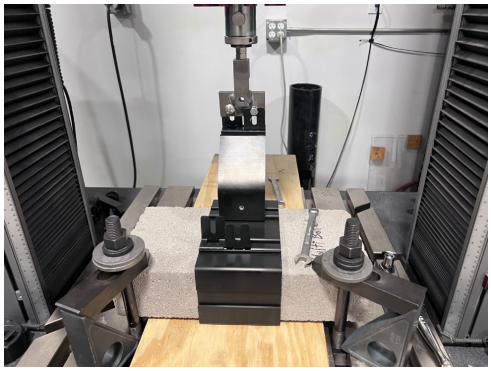

Photo 2: Compression test, setup #1

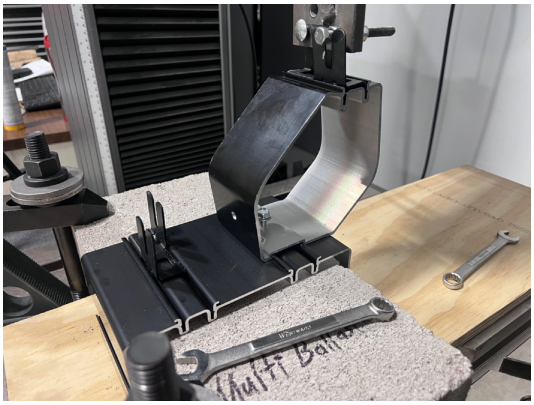

Photo 3: Compression test #1 post test

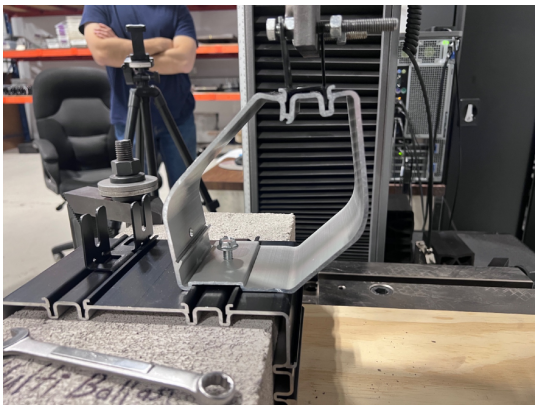

Photo 4: Compression test #1 post test

Photo 5: Compression test, setup #2

Photo 6: Compression test, setup #2

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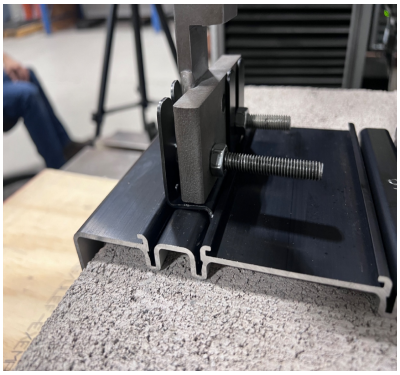

Photo 7: Compression test #2 post test

Photo 8: Compression test, setup #3

Photo 9: Compression test, setup #3

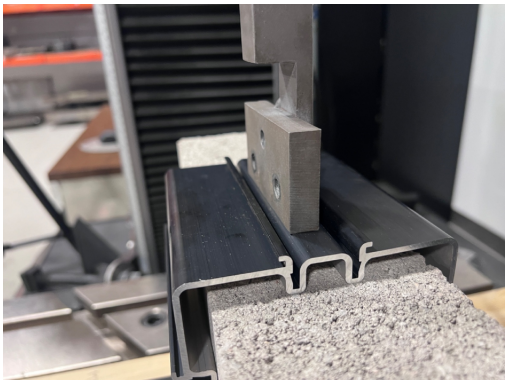

Photo 10: Compression test #3 post test