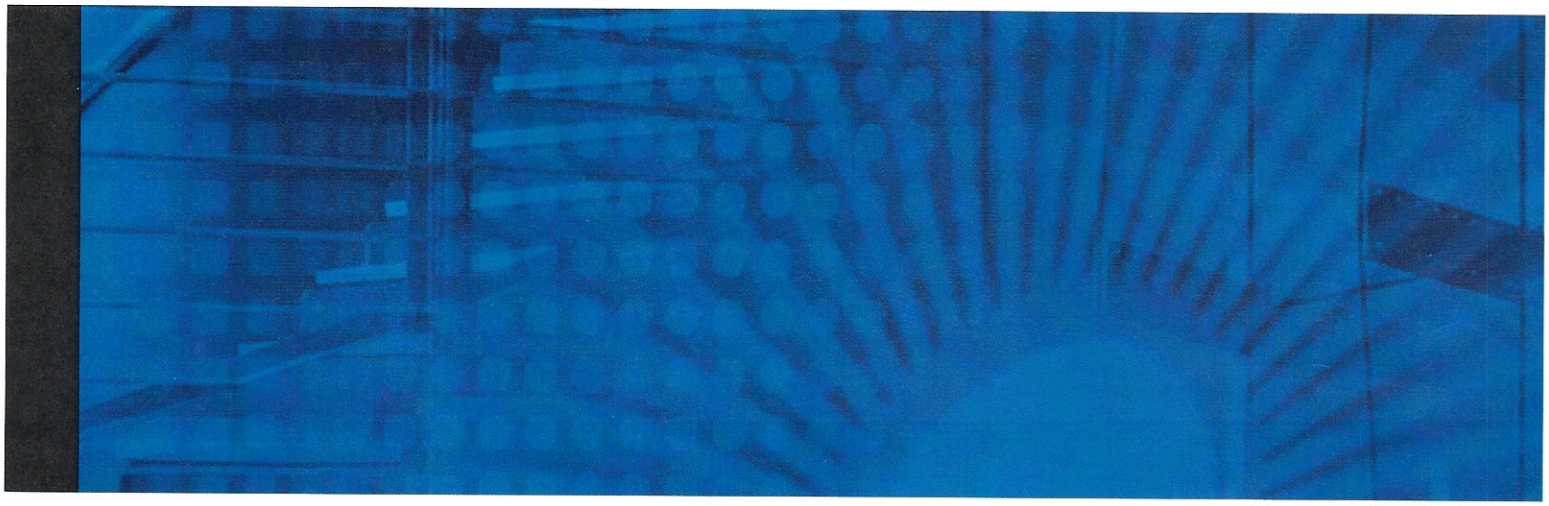
E-Beam HD™

Cold-Formed Insulated Composite Structural Elements

Engineering/Analysis Report



February 2012

kpff Consulting Engineers

Engineering/Analysis Report

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1. Introduction

The E-Beam HD™, as manufactured by Evolution 1, LLC, is a pre-insulated header element made of gauge metal structural channels surrounding a core of polystyrene insulation. The two outer cold-formed steel channels are adhered to the foam core with glue. The resulting member exhibits increased strength over that provided by the individual steel sections alone. Figure 1 in Appendix A depicts the standard E-Beam HD shapes that were tested.

The purpose of this product is to provide an insulated single piece member as a substitution for built-up beams, typically used for window header members in cold-formed framed structures. Field-assembled, built-up beams are typically not insulated, since the hollow cells created within built-up elements are not accessible to the insulation installer. This results in a thermal gap in the exterior wall of structures where they are used. The E-Beam HD members provide a one-piece structural element that includes the side members and core insulation for a typical box header installation. It avoids the labor involved with installing individual pieces and field injecting foam to accomplish a fully insulated header. Top and bottom tracks would then be installed per the project requirements.

2. Purpose of Testing

Since the E-Beam HD is a custom element made of cold-formed steel with a foam core, the increase in design section properties over that of a bare steel section must be established by calculation or based on testing. The purpose of the beam testing program was to establish the bending strength of these elements and to document the effect that the foam core has in increasing the available strength of these sections. The results of this testing program were then used to develop a methodology to determine, by calculation, the section properties and bending strengths of the whole family of E-Beam HD shapes.

3. Testing Setup

The tests were configured in accordance with the American Iron and Steel Institute Testing Standard AISI S911-08 and were conducted by Mayes Testing Engineers, Inc. at their lab in Lynnwood, Washington. Refer to the Mayes Testing Report, dated December 6, 2011. The test specimens consisted of 10-foot-6-inch-long E-Beam HD sections of 50 ksi 54 mil. (16 ga.) steel. Two types of members were tested; a typical E-Beam HD section with two channels and the same section with top and bottom capping tracks. The channels of the typical E-Beam HD section were connected with steel straps and No. 8 screws at 12 inches on center.

The specimens were placed in a hydraulic compression testing machine (see Figure 2 in Appendix A) so as to have a 10-foot-0-inch span between the centers of the support bearings. Those bearings consisted of a rocker bearing of a round bar. The beams were loaded in a two-point configuration with steel plate and round bar bearings at the load points which were set 28 inches apart, straddling the mid-span of the

member. The beams were tested in both the strong and weak axis. A steel spreader beam spanned between the load points and was in turn loaded at a single mid-point location with a 30,000 pound capacity load cell. A dial gauge was used to determine the deflection of the beam at mid-span. This configuration develops a constant bending moment in the center area between load points.

The beams were loaded continuously until failure, while load and deflection readings were taken at 200-pound increments of load. Failure was indicated when the beam would no longer resist increasing load. Load/deflection curves were then plotted in the Mayes Testing report.

Three identical specimens were tested for each of the strong axis bending and weak axis bending configurations for the standard section and the section with top and bottom capping tracks. A single empty section (no foam core) was tested for each configuration. A total of 16 beams were tested.

To control lateral deflection and torsional distortion, lateral bracing was provided near the two load points and at the end supports. At the load points, this bracing consisted of vertical rollers so as to prevent resistance to vertical movement.

4. Test Results

STRONG AXIS BENDING

Strong axis bending is about the x-x axis as shown in Figure 1 located in Appendix A. In a typical window head type installation this bending direction would typically result from vertical gravity loading of the wall above an opening.

For bending in the strong axis direction, all E-Beam HD test specimens exhibited the same mode of distortion and failure. When loaded, the stiffened compression flanges buckled inward and the compression portion of the web buckled outward (see Figures 3 and 4 in Appendix A). Figure 5 is a section cut through the failure plane that shows the web buckling and tensile failure of the foam at the failure plane of an E-Beam HD.

WEAK AXIS BENDING

Weak axis bending is about the y-y axis as shown in Figure 1 located in Appendix A. In a typical window head type installation, this bending direction would resist out-of-plane loading on the wall, such as wind loading.

For bending in the weak axis direction, the E-Beam HD test specimens without capping tracks had a different failure mode than the E-Beam HD specimens with capping tracks. When loaded, the sections without capping tracks had a shear failure in the foam adjacent to the supports (see Figure 6 in Appendix A). The deflections at failure in the sections without capping tracks were in excess of L/60. When loaded, the sections with capping tracks sheared some of the connecting screws and exhibited compression flange buckling of the capping tracks (see Figure 7 in Appendix A). The deflections at failure in the sections with capping tracks were in excess of L/80.

5. Use of Test Results

The North American Specification of the Design of Cold-Formed Steel Structural Members (AISI S100-2007) sets forth, in Section F, a methodology by which testing results can be used to establish member strength for bending. The average of the three failure loads for each group of specimens was used as the representative loading capacity at failure. The failure moment was then determined from that load and the beam loading configuration. The sections with capping tracks were tested to determine if the E-Beam HD section acted compositely with the capping tracks. From the results, it was determined that the capping tracks do not act compositely with the E-Beam HD section. The results of the tests with the capping tracks were not used to develop the capacity charts.

The effective moment for the different test specimens was developed based on Section F1.2 of the AISI S100-2007 code: Allowable Strength Design by reducing the tested failure moment by a safety factor. This average reduced tested failure moment is referred to as the reduced tested capacity. The safety factor of 1.85 was determined in accordance with Eq F1.2-2.

Compared with the theoretical effective strong axis bending capacity of a bare steel shape, the reduced tested capacity of an 8-inch-deep by 54 mil. (16 ga.) section was 25 percent stronger. This 25 percent increase was applied to the effective bending capacity of 6-inch, 8-inch, 10-inch, and 12-inch-deep sections of 54 mil. (16 ga.) and 43 mil. (18 ga.) material. As the depth to thickness ratio increases, it is more likely that the shapes will experience local buckling so extrapolation of the results is less reliable. In addition, as heavier gauges are used, the foam is less effective in providing out of plane bracing for the steel shape. Therefore, the capacity increase as determined by the test results is not applied to sections thicker than 54 mil (16 ga.) or deeper than 12 inches.

For weak axis bending, the methodology of AISI S100-2007 Section F does not apply. Because the failure occurs in the low density foam, which is not a codified structural material, the principles of cold-formed steel design cannot be used. While an effective weak axis moment cannot be extrapolated to other E-Beam HD sizes, an effective stiffness can be determined and extrapolated. The effective stiffness of the tested E-Beam HD shapes was determined to be 27 percent greater than the effective stiffness of a bare steel section. This increase was applied to the effective stiffness of 6-inch and 8-inch shapes of 54 mil. (16 ga.) and 43 mil. (18 ga.) material.

6. Conclusions

This testing program established the strong axis bending moment capacity at failure of three 54 mil. (16 ga.) E-Beam HD specimens and three 54 mil. (16 ga.) E-Beam HD with capping track specimens. For strong axis bending, the failure modes were consistent regardless of the presence of the capping tracks. Little, if any, composite action was observed in the specimens with capping tracks. With the connecting screws located at a typical spacing of 12 inches on center, there appears to be enough slippage between the sections that effective composite action does not develop. For weak axis bending, the failure mode depended on the presence of the capping tracks. In the weak axis direction, capping tracks do provide the majority of the bending strength, which is the typical assumption most designers

follow. However, because the capping tracks are not an integral part of the E-Beam HD, the added capacity in the weak axis direction from the capping tracks is not included in the E-Beam HD section properties table.

The test results in the strong axis direction were used to establish allowable bending moments for 6-inch, 8-inch, 10-inch, and 12-inch sections of 54 mil. (16 ga.) and 43 mil. (18 ga.) material. The increase in allowable bending strength over that of a bare steel shape can be attributed to the foam core delaying the onset of local buckling.

The weak axis deflection from testing was greater than L/60 and well beyond the typical accepted limits. Therefore, the lateral capacity of the bare E-Beam HD without capping tracks is governed by stiffness and not flexural strength. The test results in the weak axis direction were used to establish effective stiffnesses for 6-inch and 8-inch-deep sections of 54 mil. (16 ga.) and 43 mil. (18 ga.) material. The increase in effective stiffness can be attributed to the presence of the foam allowing the section to act compositely. Because the foam does not have any significant structural strength, the strength of the bare steel sections cannot be amplified.

The effective section properties and moment capacities developed from the testing program appear in Table A of Appendix A.

Appendix A

Figures, Photographs, and Tables

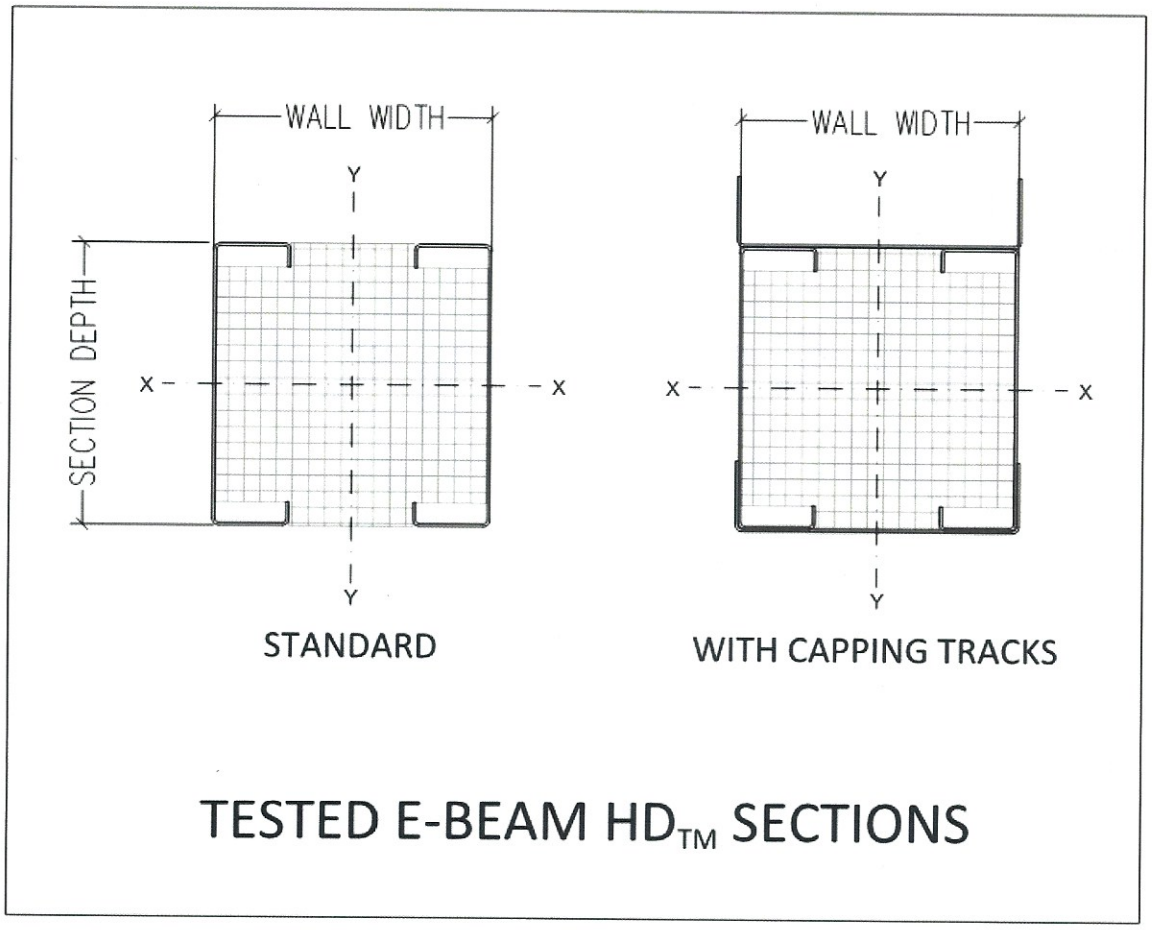


Figure 1: Tested E-Beam HD Sections

Figure 2: Testing Setup

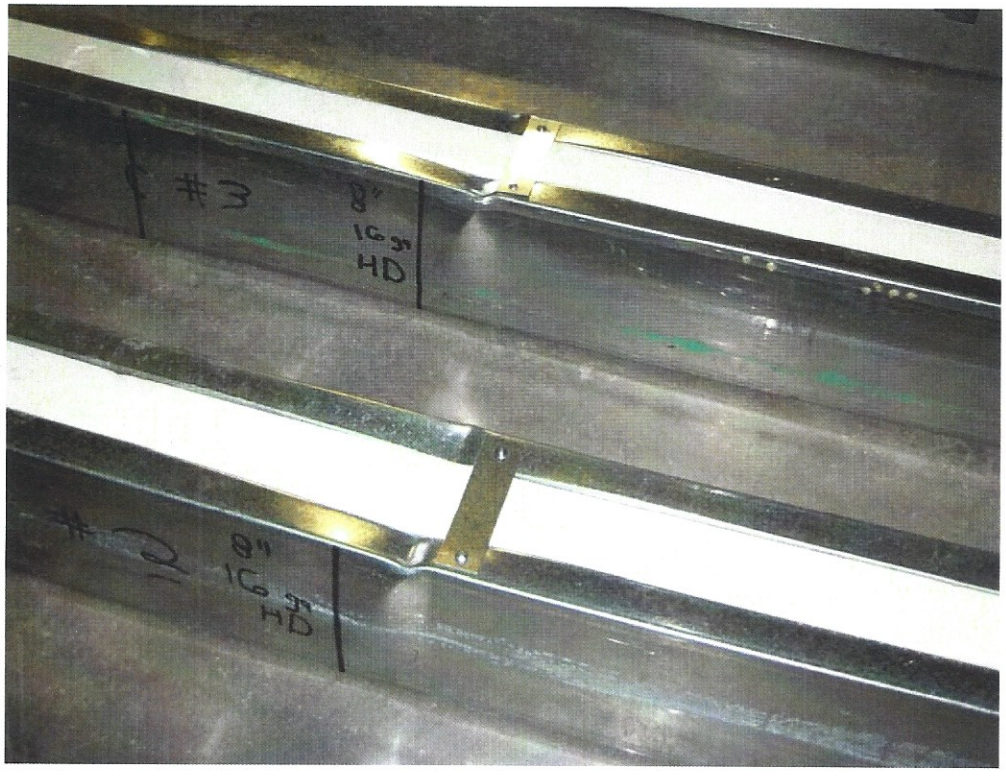


Figure 3: Strong Axis Bending Failure

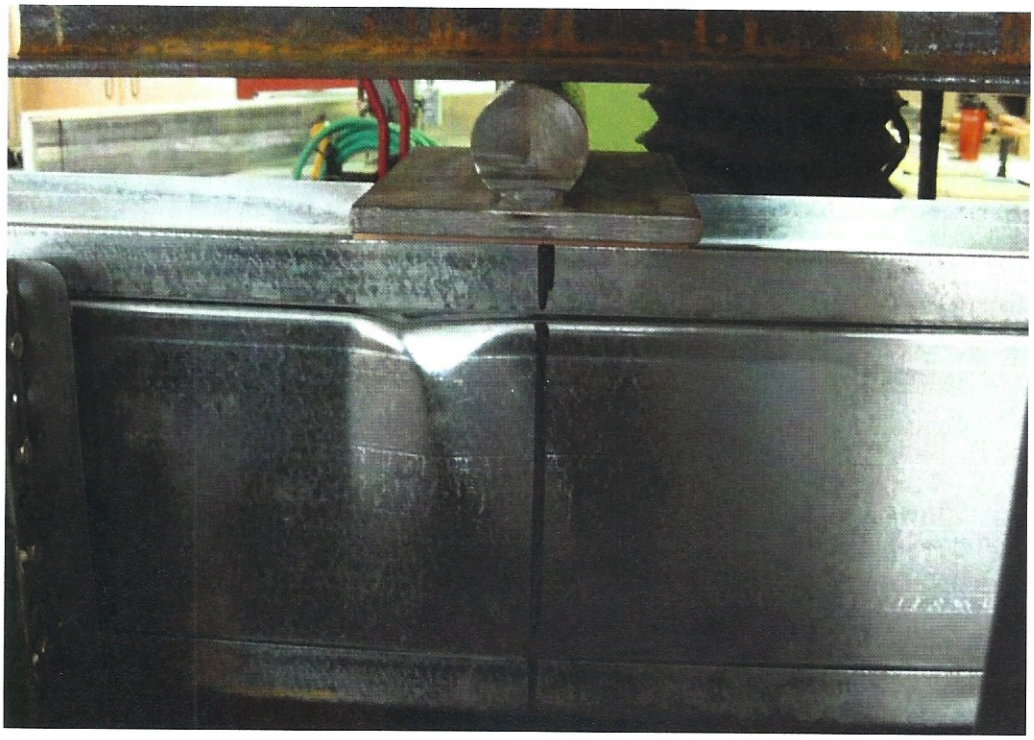


Figure 4: Strong Axis Bending at Failure: Section with Capping Tracks

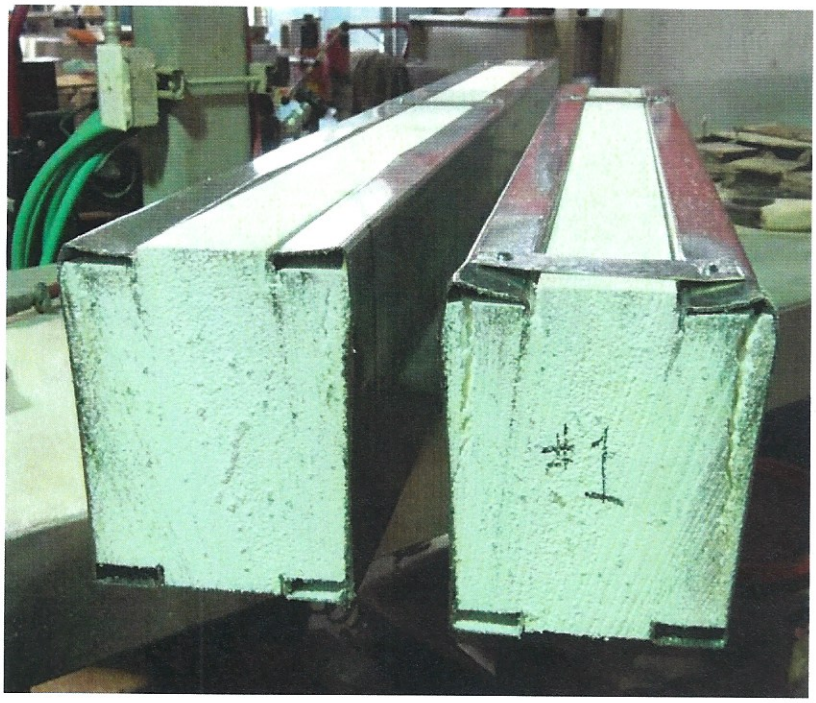


Figure 5: Strong Axis Bending at Failure: Compression Flange Buckling, Web Buckling, and Foam Cracking

Figure 6: Weak Axis Bending: Foam Shear Failure

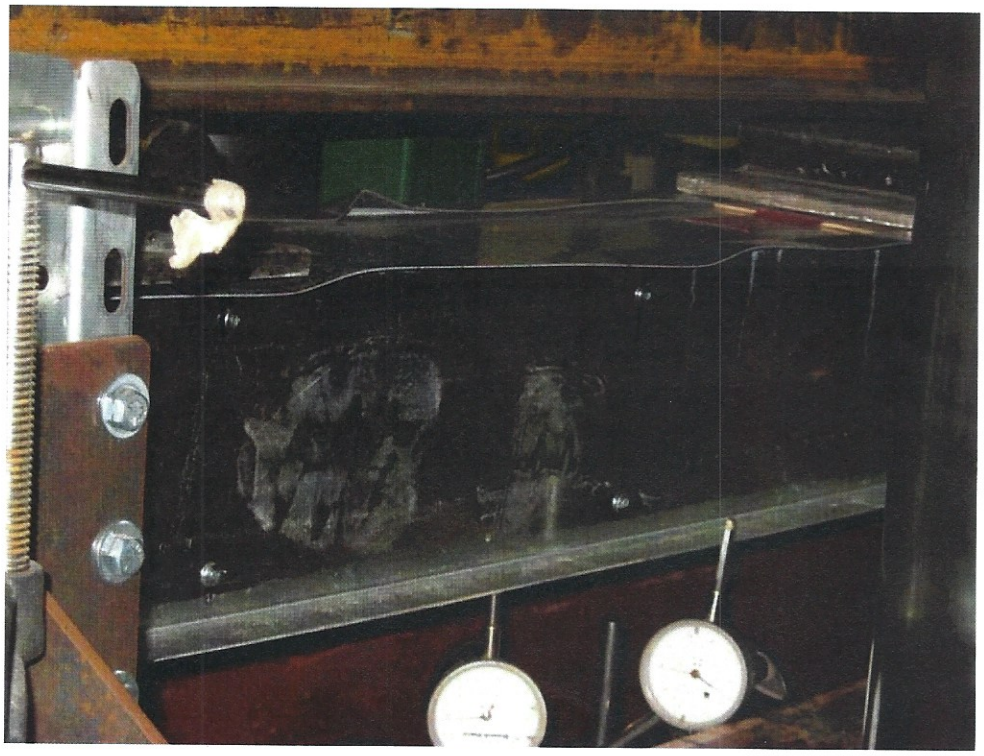


Figure 7: Weak Axis Bending: Compression Flange Buckling of Capping Tracks

Table A: Section Properties

E-BEAM HD$_{TM}$ SECTION PROPERTIES TABLE

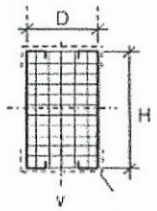
	Design Thickness	Gauge	Gross Properties						Effective Properties				
			F_y	Area	Weight	I_x	S_x	R_x	I_{xe}	S_{xe}	M_{ax}	V_{ax}	$(EI)_{ye}$
	(in)	(No.)	(ksi)	(in^2)	(lb/ft)	(in^4)	(in^3)	(in)	(in^4)	(in^3)	(k-in)	(lb)	(k-in^2)
EB6-600S162-43 HD[1]	0.0451	18	33	0.894	3.04	4.632	1.544	2.276	4.64	1.93	41.70	2832	36682
EB8-600S162-43 HD[1]													70179
EB6-600S162-54 HD[1]	0.0566	16	50	1.112	3.78	5.720	1.906	2.268	5.72	2.38	52.93	5478	45666
EB8-600S162-54 HD[1]													87026
EBD-600S162-68 HD[2]	0.0713	14	50	1.386	4.72	7.050	2.350	2.255	7.06	2.36	53.58	8694	-
EB6-800S162-43 HD[1]	0.0451	18	33	1.074	3.66	9.266	2.316	2.937	9.00	2.55	50.35	2102	40563
EB8-800S162-43 HD[1]													77102
EB6-800S162-54 HD[1]	0.0566	16	50	1.340	4.56	11.472	2.868	2.926	11.40	3.33	65.90	4182	50482
EB8-800S162-54 HD[1]													95588
EBD-800S162-68 HD[2]	0.0713	14	50	1.672	5.68	14.178	3.544	2.912	14.18	3.48	68.64	8442	-
EBD-1000S162-43 HD[1]	0.0451	18	33	1.254	4.26	16.050	3.210	3.578	15.04	3.25	64.35	1672	-
EBD-1000S162-54 HD[1]	0.0566	16	50	1.566	5.32	19.900	3.980	3.565	19.26	4.30	85.05	3322	-
EBD-1000S162-68 HD[2]	0.0713	14	50	1.956	6.66	24.650	4.930	3.550	24.52	4.56	89.96	6690	-
EBD-1200S162-54 HD[1]	0.0566	16	50	1.792	6.10	31.460	5.244	4.190	29.48	5.28	104.20	2754	-
EBD-1200S162-68 HD[2]	0.0713	14	50	2.242	7.62	39.036	6.506	4.173	37.92	5.64	111.32	5542	-
EBD-1400S162-54 HD[2]	0.0566	16	50	2.018	6.86	46.604	6.658	4.806	42.20	5.00	98.64	2354	-
EBD-1400S162-68 HD[2]	0.0713	14	50	2.526	8.60	57.904	8.272	4.788	54.72	6.72	132.66	4730	-

"D" is the wall thickness. See typical nomenclature

Notes:

1. Based on direct testing in accordance with AISI S911-08 and the AISI S100-2007 specification, an increase in effective strong axis section modulus and effective strong axis moment of approximately 25% has been applied to 6", 8", 10", and 12" deep sections with thicknesses of 43 mil and 54 mil.
2. Section properties are for two stud shapes per the SSMA Technical Catalog and have not been increased.
3. Typically, for out-of-plane (weak axis) loading, top and bottom tracks would be added to the E-Beam HD by the design engineer. However, the foam core does provide a limited amount of composite action of the E-Beam section alone. The weak axis capacity of the E-Beam HD by itself is controlled by deflection. The effective stiffness in this direction, $(EI)_{ye}$, corresponds to a deflection ratio of L/360 and is based on testing for the 6" E-Beam HD.
4. User should check end reaction for web crippling.
5. Bending capacities are based on the assumption that the compression flange is adequately laterally braced on both sides.
6. Allowable Moment and Shear Values are calculated assuming a negligible axial load. Load bearing jamb studs are to be designed for combined axial and bending loads by a qualified professional.
7. Strength increase due to cold work of forming has been incorporated per AISI 2007 Specification A7.2.
8. The effective Moment of Inertia for deflection has been calculated using Procedure 1 of the AISI S100-2007 Specification for serviceability determination.
9. The distortional buckling limit state is not considered in this table. Consideration of distortional buckling may result in lower strengths when restraint against distortional buckling is not provided.
10. If punch-outs are used in members, values may be smaller than those listed above and shall be per the AISI S100-2007 Specification.

E-BEAM HD™ NOMENCLATURE



D (Wall Thickness) — H (Height)

EB 6 - 800S162-54 HD

Flange Width — Mil / ga.

SSMA Section Designation

Example E-Beam HD Size Designation

Top and bottom tracks are to be specified as required for design
The designer should specify the wall thickness and C-stud shapes to be used in the E-Beam HD
The designer is responsible for determining the adequacy of the sections for their intended use.

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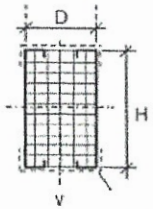
ENVIRO Beam Header Members for 6 inch Walls: E-BEAM HD™ TABLE 1 - ALLOWABLE UNIFORM LOADS, lbs/ft[1,2,3,4,5,6,9,10.]

MEMBER PROPERTIES					HEADER SPANS, FT: Deflection Limit equals Span/ 360																					
Member Designation	Wt. lbs/ft	Ma k-in	Ixe in^4	Va kips	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
EB6-600S162-043 HD[7]	***3.04***	***36.15***	***4.63***	***2.83***	***371***	***272***	***197***	***146***	***111***	***86***	***68***	***54***	***44***	***35***	***29***	***24***											
600T150-43 T&B[8]	2.76	18.72	***5.02***	2.75	***195***	***154***	***125***	***103***	***87***	***74***	***64***	***55***	***49***	***43***	***38***	***32***	***27***										
EB6-600S162-054 HD[7]	***3.78***	***64.75***	***5.72***	***5.65***	***481***	***336***	***243***	***181***	***137***	***107***	***84***	***67***	***54***	***44***	***36***	***29***	***24***	20									
600T150-54 (50ksi) T&B[8]	3.46	36.48	***6.35***	5.46	***380***	***300***	***243***	***201***	***161***	***126***	***101***	***82***	***68***	***56***	***48***	***40***	***35***	23	20								
EB6-600S162-068 HD[7]	4.72	71.38	7.05	10.70	593	414	299	222	169	131	103	82	66	54	44	36	29	24	20								
600T150-68 (50ksi) T&B[8]	4.36	53.36	6.32	10.70	540	379	276	208	160	126	101	82	67	56	47	40	35	30	26	23	20						
EB6-800S162-043 HD[7]	***3.66***	***45.83***	***9.00***	***2.10***	***471***	***371***	***299***	***246***	***206***	***173***	***137***	***110***	***90***	***74***	***61***	***51***	***43***	36	31	26	22						
600T150-43 T&B[8]	2.76	18.72	***5.16***	2.75	***195***	***154***	***125***	***103***	***87***	***74***	***64***	***55***	***49***	***43***	***39***	***33***	***28***										
EB6-800S162-054 HD[7]	***4.56***	***82.03***	***11.20***	***4.18***	***846***	***663***	***481***	***360***	***275***	***215***	***170***	***137***	***111***	***92***	***76***	***63***	***53***	45	38	32	27	23	20				
600T150-54 (50ksi) T&B[8]	3.46	36.48	***6.51***	5.46	***380***	***300***	***243***	***201***	***165***	***130***	***104***	***84***	***69***	***58***	***49***	***41***	***36***	23	20								
EB6-800S162-068 HD[7]	5.68	90.22	14.14	8.44	930	733	591	454	348	271	215	173	141	116	96	80	67	57	48	41	35	30	25	21			
600T150-68 (50ksi) T&[8]	4.36	53.36	6.32	10.70	540	379	276	208	160	126	101	82	67	56	47	40	35	30	26	23	20						
EB6-1000S162-043 HD[7]	***4.26***	***56.23***	***15.05***	***1.67***	***407***	***365***	***327***	***297***	***253***	***215***	***184***	***160***	***139***	***123***	***106***	***89***	***75***	61	55	47	41	35	30	26	23	20	
600T150-43 T&B[8]	2.76	18.72	3.78	2.75	195	154	125	103	87	74	60	49	40	34	28	24	21										
EB6-1000S162-054 HD[7]	***5.32***	***100.93***	***18.78***	***3.32***	***816***	***729***	***656***	***547***	***458***	***365***	***290***	***234***	***192***	***158***	***132***	***111***	***94***	80	68	59	51	44	38	33	29	25	22
600T150-54 (50ksi) T&B[8]	3.46	36.48	4.80	5.46	380	288	210	158	121	95	76	62	51	43	36	31	26	23	20								
EB6-1000S162-068 HD[7]	6.66	112.70	23.96	6.69	1163	917	740	610	511	434	371	299	245	202	169	142	120	102	87	75	65	56	49	42	37	32	28
600T150-68 (50ksi) T&B[8]	4.36	53.36	6.32	10.70	540	379	276	208	160	126	101	82	67	56	47	40	35	30	26	23	20						
EB6-1200S162-054 HD[7]	***6.10***	***116.88***	***28.60***	***2.75***	***673***	***602***	***541***	***491***	***449***	***414***	***384***	***337***	***295***	***245***	***205***	***173***	***147***	125	108	93	81	70	62	54	47	42	37
600T150-54 (50ksi) T&B[8]	3.46	36.48	4.80	5.46	380	288	210	158	121	95	76	62	51	*43*	*36*	*31*	26	23	20								
EB6-1200S162-068 HD[7]	7.62	132.28	36.78	5.54	1366	1077	870	717	600	510	438	380	332	293	260	222	189	162	139	120	104	91	79	70	61	54	48
600T150-68 (50ksi) T&B[8]	4.36	53.36	6.32	10.70	540	379	276	208	160	126	101	82	67	56	47	40	35	30	26	23	20						
EB6-1400S162-054 HD[7]	6.86	104.26	40.73	2.35	571	513	460	418	382	352	326	299	261	230	204	182	163	147	133	121	110	101	91	80	71	63	56
600T150-54 (50ksi) T&B[8]	3.46	36.48	4.80	5.46	380	288	210	158	121	95	76	62	51	43	36	31	26	23	20								
EB6-1400S162-068 HD[7]	8.60	149.12	52.75	4.73	1161	1038	933	809	677	575	494	429	375	331	294	262	236	212	192	175	154	135	118	104	92	82	72
600T150-68 (50ksi) T&B[8]	4.36	53.36	6.32	10.70	540	379	276	208	160	126	101	82	67	56	47	40	35	30	26	23	20						

Notes:

1. For additional notes see: E-BEAM HD™ SECTION PROPERTIES TABLE dated 11/28/2012.
2. Values shown bold and Italicize indicate calculations are based on properties from table referenced in note 1.
3. All other values are based on properties from the 2012 SSMA Product Technical Guide Section Properties.
4. The selfweight of Member has been accounted for in Allowable Vertical Uniform Loads.
5. Deflection is limited to L/360 (Span/360) for both vertical and horizontal directions.
6. Blank spaces indicate Allowable Uniform Loads are less than 20 lbs/ft
7. This row indicated the Allowable Vertical Uniform Loads.
8. This row indicates the Allowable Horizontal Uniform Loads.
9. Tracks T&B (Top and Bottom) are by others. Connect tracks to E-Beams with minimum two rows #8 screws @12"o.c..
10. Testing limitations limit added strengths to 20 feet or less.

E-BEAM HD™ NOMENCLATURE



D (Wall Thickness) — H (Height)

EB 6 - 800S162-54 HD

Flange Width — Mil / ga.

SSMA Section Designation

Example E-Beam HD Size Designation

Top and bottom tracks are to be specified as required for design
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ENVIRO Beam Header Members for 8 inch Walls: E-BEAM HD$_{TM}$ TABLE 2 - ALLOWABLE UNIFORM LOADS, lbs/ft[1,2,3,4,5,6,9,10.]

MEMBER PROPERTIES					HEADER SPANS, FT: Deflection Limit equals Span/ 360																					
Member Designation	Wt. lbs/ft	Ma k-in	Ixe in^4	Va kips	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
EB8-600S162-043 HD[7]	***3.04***	***36.15***	***4.63***	***2.83***	***370***	***271***	***196***	***146***	***111***	***86***	***67***	***54***	***43***	***35***	***28***	***23***											
800T150-43 T&B[8]	3.38	25.90	***9.76***	2.06	***270***	***213***	***173***	***143***	***120***	***102***	***88***	***77***	***67***	***60***	***53***	***48***	***43***	***35***	***30***	***27***	***23***	***21***					
EB8-600S162-054 HD[7]	***3.78***	***64.75***	***5.72***	***5.65***	***480***	***335***	***242***	***180***	***137***	***106***	***83***	***66***	***53***	***43***	***35***	***28***	***23***										
800T150-54 (50ksi) T&B[8]	4.24	50.54	***12.33***	4.08	***526***	***416***	***337***	***278***	***234***	***199***	***172***	***150***	***132***	***110***	***92***	***79***	***67***	44	39	34	30	26	23	21	19	17	15
EB8-600S162-068 HD[7]	4.72	71.38	7.05	10.70	592	413	298	221	168	130	102	81	65	53	43	35	28	23									
800T150-68 (50ksi) T&B[8]	5.34	75.16	12.72	8.17	783	619	501	414	322	253	203	165	136	113	95	81	69	60	52	46	40	36	32	28	25	23	21
EB8-800S162-043 HD[7]	***3.66***	***45.83***	***9.00***	***2.10***	***470***	***370***	***298***	***245***	***205***	***172***	***136***	***110***	***89***	***73***	***60***	***50***	***42***	35	30	25	21						
800T150-43 T&B[8]	3.38	25.90	***9.99***	2.06	***270***	***213***	***173***	***143***	***120***	***102***	***88***	***77***	***67***	***60***	***53***	***48***	***43***	35	30	27	23	21	18	16	15	13	12
EB8-800S162-054 HD[7]	***4.56***	***82.03***	***11.20***	***4.18***	**846**	**663**	**481**	**359**	**274**	**214**	**170**	**136**	**111**	***91***	***75***	***63***	***52***	44	37	31	27	23					
800T150-54 (50ksi) T&B[8]	4.24	50.54	***12.62***	4.08	***526***	***416***	***337***	***278***	***234***	***199***	***172***	***150***	***132***	***112***	***95***	***80***	***69***	44	39	34	30	26	23	21			
EB8-800S162-068 HD[7]	5.68	90.22	14.14	8.44	929	732	590	453	347	270	214	172	140	115	95	79	66	56	47	40	34	29	24	20			
800T150-68 (50ksi) T&[8]	5.34	75.16	12.72	8.17	783	619	501	414	322	253	203	165	136	113	95	81	69	60	52	46	40	36	32	28	25	23	21
EB8-1000S162-043 HD[7]	***4.26***	***56.23***	***15.05***	***1.67***	***406***	***364***	***327***	***296***	***253***	***214***	***184***	***159***	***139***	***122***	***105***	***88***	***75***	60	54	46	40	34	30	26	22		
800T150-43 T&B[8]	3.38	25.90	7.38	2.06	270	213	173	143	120	102	88	77	67	60	53	47	40	35	30	27	23	21					
EB8-1000S162-054 HD[7]	***5.32***	***100.93***	***18.78***	***3.32***	***816***	***729***	***655***	***547***	***458***	***364***	***290***	***234***	***191***	***157***	***131***	***110***	***93***	79	68	58	50	43	37	32	28	24	21
800T150-54 (50ksi) T&B[8]	4.24	50.54	9.38	4.08	526	416	337	278	234	187	149	122	100	83	70	60	51	44	39	34	30	26	23	21			
EB8-1000S162-068 HD[7]	6.66	112.70	23.96	6.69	1162	916	739	609	510	433	370	298	244	201	168	141	119	101	86	74	64	55	48	41	36	31	27
800T150-68 (50ksi) T&B[8]	5.34	75.16	12.72	8.17	783	619	501	414	322	253	203	165	136	113	95	81	69	60	52	46	40	36	32	28	25	23	21
EB8-1200S162-054 HD[7]	***6.10***	***116.88***	***28.60***	***2.75***	***672***	***602***	***540***	***490***	***449***	***413***	***383***	***336***	***294***	***244***	***204***	***172***	***146***	125	107	92	80	70	61	53	47	41	36
800T150-54 (50ksi) T&B[8]	4.24	50.54	9.38	4.08	526	416	337	278	234	187	149	122	100	*83*	*70*	*60*	*51*	44	39	34	30	26	23	21			
EB8-1200S162-068 HD[7]	7.62	132.28	36.78	5.54	1365	1076	869	716	599	509	437	379	332	292	259	221	188	161	138	119	103	90	78	69	60	53	47
800T150-68 (50ksi) T&B[8]	5.34	75.16	12.72	8.17	783	619	501	414	322	253	203	165	136	113	95	81	69	60	52	46	40	36	32	28	25	23	21
EB8-1400S162-054 HD[7]	6.86	104.26	40.73	2.35	571	512	460	417	381	351	325	298	260	229	203	181	163	147	133	120	110	100	90	79	70	62	55
800T150-54 (50ksi) T&B[8]	4.24	50.54	9.38	4.08	526	416	337	278	234	187	149	122	100	83	70	60	51	44	39	34	30	26	23	21			
EB8-1400S162-068 HD[7]	8.60	149.12	52.75	4.73	1160	1037	932	808	676	574	493	428	374	330	293	261	235	211	191	174	153	134	117	103	91	81	71
800T150-68 (50ksi) T&B[8]	5.34	75.16	12.72	8.17	783	619	501	414	322	253	203	165	136	113	95	81	69	60	52	46	40	36	32	28	25	23	21

Notes:

1. For additional notes see: E-BEAM HD$_{TM}$ SECTION PROPERTIES TABLE dated 11/28/2012.
2. Values shown bold and Italicize indicate calculations are based on properties from table referenced in note 1.
3. All other values are based on properties from the 2012 SSMA Product Technical Guide Section Properties.
4. The selfweight of Member has been accounted for in Allowable Vertical Uniform Loads.
5. Deflection is limited to L/360 (Span/360) for both vertical and horizontal directions.
6. Blank spaces indicate Allowable Uniform Loads are less than 20 lbs/ft
7. This row indicated the Allowable Vertical Uniform Loads.
8. This row indicates the Allowable Horizontal Uniform Loads.
9. Tracks T&B (Top and Bottom) are by others. Connect tracks to E-Beams with minimum two rows #8 screws @12"o.c..
10. Testing limitations limit added strengths to 20 feet or less.

SECTION 054023
THERMALLY INSULATED COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Manufactured, structurally engineered, thermally insulated, thermally-broken, cold-formed metal framing boxed channel assemblies for exterior perimeter wall framing, parapets, and roof curbs.

1. Insulated, thermally broken box header framing.
2. Insulated king boxed stud framing.
3. Insulated boxed header & sill framing
4. Connection plates.
5. Insulated boxed roof parapet and roof curb units and pre-insulated Skylight curbs.

B. Related Requirements:

1.	Section 054000	-	Cold-Formed Metal Framing: For installation of work of this Section
2.	Section 072113	-	Rigid Foam Board Insulation
3.	Section 072115	-	Semi-Rigid Mineral Board Insulation

1.2 REFERENCES

A. Reference Standards: Conform to provision of Section [014219 -] .

B. American Iron and Steel Institute (AISI): http://www.steel.org/

1.	AISI S100	-	North American Specification for the Design of Cold-Formed Steel Structural Members
2.	AISI S200	-	North American Cold-Formed Steel Framing Standard - General Provisions
3.	AISI S211	-	North American Cold-Formed Steel Framing Standard - Wall Stud Design
4.	AISI S212	-	North American Standard for Cold-Formed Steel Framing - Header Design
5.	AISI S213	-	North American Standard for Cold-Formed Steel Framing - Lateral Design
6.	AISI 911-08	-	Testing by Mayes Testing Laboratory, Lynnwood, WA.

C. ASTM International (ASTM): http://www.astm.org/

1.	ASTM A123	-	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2.	ASTM A653	-	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process.
3.	ASTM A792	-	Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
4.	ASTM A875	-	Standard Specification for Steel Sheet, Zinc-5% Aluminum Alloy-Coated by the Hot-Dip Process.
5.	ASTM A1003	-	Standard Specification for Steel Sheet, Carbon, Metallic- and –Nonmetallic-Coated for Cold-Formed Framing Members.
6.	ASTM C272	-	Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
7.	ASTM C203	-	Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
8.	ASTM C303	-	Standard Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation

9. ASTM C518 - Standard Test Method for Steady-State Thermal Means of the Heat Flow Meter Apparatus
10. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
11. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
12. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
13. ASTM C1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.
14. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics
15. ASTM D2126 - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
16. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics
17. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
18. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials

1.3 International Code Commission (ICC) Evaluation Services:

1. ICC ES AC46 - Acceptance Criteria for Cold-Formed Framing Members
2. ICC ES AC261 - Acceptance Criteria for Connectors used with Cold-Formed Steel Structural Members

B. Steel Stud Manufacturers Association (SSMA): Product Technical Information. http://www.ssma.com

1. SSMA ICC-ES Legacy Report ER-4943P, Revised Aug 2003 after revision.
2. SSMA Product Technical Information.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Conform to Section 013113 for coordination with work of related Sections.

1. Section 054000 for integrating and installing thermally insulated framing specified by this Section into cold-formed metal framing systems

1.5 SUBMITTALS

A. Conform to submittal requirements of Section 013300.

B. Product Data:

1. Detailed description and fabrication drawings showing configurations, and design criteria for each manufactured product specified by this Section (See website; envirobeam.com for drawings of Installation Instructions for each individual Enviro-Component).
2. Accessories: Include connection plates, and anchoring devices.
3. Light Gage Steel
4. Block Foam & Insulation filler material
5. Adhesive
6. Connection devices

C. Test Results: Include:

1. Structural: Base on AISI S100 Section F methodology by independent testing laboratory. Stamp and sign written report by licensed professional engineer, registered with [the State of Washington] (See Mayes Testing Test Reports included in KPFF Engineering Reports)
    a. Strong Axis in Bending.
    b. Weak Axis in Bending.
2. Thermal Resistance (R-Value) per Insulation Mfg published test data.

D. Structural Design Calculations: Stamp and sign by licensed professional engineer, registered with [the State of Washington].
1. Comprehensive analysis of design loads,

E. Thermal Resistance (R-Value): Insulation type and thermal properties for each fabricated assembly.

F. Manufacturer's Instructions: Include installation instructions, special procedures, and conditions requiring special attention.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Employ licensed professional engineering personnel experienced in work of this Section and registered in State of Washington.
2. Maintain locally available technical product representation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Conform to provisions of Section 016510 and manufacturers instructions.

B. Ordering: Conform to manufacturer’s ordering instructions and lead time requirements to avoid construction delays.

C. Delivery: Deliver materials on manufacturer’s pallets with identification labels intact.

D. Deliver in bundles, clearly identified with manufacturer's labels intact. Verify undamaged conditions.

E. Store off ground and handle to keep clean, dry, and protected from damage due to weather and construction activities.

1.8 [FIELD CONDITIONS

A. Site Environmental Requirements: Do not install materials until site conditions conform to manufacturer installation instructions.]

B. Installers must strictly adhere to Manufactures written Installation Instructions

1.9 [WARRANTY

A. Cold Formed Framing: Manufacturer’s standard 20-year materials warranty covering defective materials of cold-formed metal framing members.]

B. Installers must strictly adhere to Manufactures written Installation Instructions

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Evolution 1, Envirobeam, specified as basis of design.
1. Cell (206) 455-1978, Email duane@envirobeam.com (Duane Den Adel, Operations Manager)
2. Cell (425) 344-1371, Email ron@envirobeam.com (Ron Den Adel, Production Manager)

3. Website http://www.envirobeam.com

B. Substitution Requests: Conform to provisions of Section 012500. Submit product data indicating conformance to specified provisions of this Section.

2.2 PERFORMANCE / DESIGN CRITERIA

A. See KPFF Engineering Reports ; Enviro-King June 2011, E-Header / Sill January 2012, E-Beam HD February 2012.

B. Thermal Insulation: [Semi-rigid mineral insulation board] [Expanded polystyrene insulation board (EPS)] [Extruded polystyrene insulation board (XPS)] Polyisosanurate insulation board.

1. Design thickness and type of insulation into system assembly.
2. Thermal analysis to be determined by thermal U-factor published by individual Mfg.Iinsulation type .

C. Load Bearing Cold Rolled Steel Framing Members: ASTM C955.

1. Minimum Effective Physical and Structural Properties: As published by the Steel Stud Manufactures Association (SSMA) Product Technical Information, conforming to ICC ER-4943P.
2. Grades:

a. ASTM A1003, Structural Grade 50 Type H (ST50H) (F_y = 50 ksi) for 97, 68, and 54 mil (12, 14 and 16 gauge) framing members.
b. ASTM A1003, [ASTM A792, or ASTM A875] Structural Grade 33 Type H (ST33) (F_y = 33 ksi) for 43 and 33 mil (18 and 20 gauge) framing members.

D. Hot-Dip Aluminum-Zinc Alloy-Coating: Galvanized ASTM A653 G60 [Hot-Dip Aluminum-Zinc Alloy-Coating: ASTM A792, Structural Steel (SS), Grade 50, Class 1 or 4, Coating Destination AZ55].

2.3 THERMALLY INSULATED COLD-FRAMED STEEL WALL PRODUCTS

A. Refer to Enviro-Beam Span Load Tables, suggested installation instructions, and parts list section properties.

1. Thermal Resistance (R-Value): Approximately R-4 per inch of wall thickness

B. E-Beam HD - Pre-Insulated Steel Header Beam:

1. Standard Widths: 6 and 8 inch.
2. Standard Depths: Varies.
3. Available Steel Thickness: 18 gauge (43 mil) through 12 gauge (97 mil).

C. E-Header Sill – Pre-Insulated Steel Header Sill: A lighter duty option to the E-Beam HD

D. E-King – Pre-Insulated Alternative To Standard Dual Stud:

1. Standard Depths: For 4, 6, and 8 inch wall depths.
2. Standard Width: 3 ¼”inch.
3. Available Steel Thickness: 20 gauge (33 mil) through 12 gauge (97 mil).

E. Connection Plate – Connection Plate with Pre-Punched Holes: Refer to manufacturer’s table.

1. Steel Grade: Minimum 33,000 psi.
2. Punched Holes: 25 each plate for No. 10 and No. 8 self-drilling, self-tapping screws.
3. Capacities: As published by manufacturer and as determined by professional engineer of record. [694 pounds to 2836 pounds, two plates on each side of header depending on screw placement, designed to AISI S100 (NAS) 2001 <2012 is current edition> Section E4.3 (Shear).]
4. Thickness: 16 or 14 gauge (54 or 68 mils).

5. Width: 7-1/2 inch.
6. Height: 5-1/2 and 7-1/2 inch.

2.4 THERMALLY INSULATED COLD-FRAMED ROOFING PRODUCTS

A. E-Roof Curb:

B. E-Skylight Curb:

C. E - Mechanical Curb.

2.5 FASTENERS, , CONNECTORS, ANCHORAGE, AND ACCESSORIES

A. Steel Drill Screws: Corrosion-resistant with minimum 3/8 minimum penetration into steel members.

1. Steel Tapping Screws: ASTM C1513 for steel framing connections.
2. Steel Drill Screws: ASTM C954 for connections of gypsum panel products to steel framing members

B. Connector and Anchorage Devices:

1. Power driven and powder actuated anchors, bolts, nuts, and washers [as shown on Structural Drawings, or] as accepted for transfer of design loads, conforming to ICC ES AC308.
2. Galvanize to 1.25 ounce psf conforming to ASTM A123.

2.6 THERMAL INSULATION CORE

A. Semi-Rigid Mineral Insulation Board:

Property	Result	Test Method
Density	4 psf [8 psf] [13 PSF]	ASTM C303
Thermal Resistance (R-Value) at 75 degrees F	R - 4.3 per inch	ASTM C518
Water Vapor Transmission (desiccant method)	30 - 50 perms	ASTM E96
Combustion Characteristics	Non-Combustible	ASTM E136
Surface Burning Characteristics	UL 723 / IBC Class A	ASTM E84
Flame Spread	0	
Smoke Developed	0	
Moisture Resistance	Non-hydroscopic (does not absorb/hold water)	
Sorption	0.03 percent[1] or less	ASTM C1104
Absorption	1.0 percent or less	ASTM E136
Fungi and Bacteria	Does not promote growth	ASTM C1338
Corrosion Resistance	Passes	ASTM C665

[1] ASTM C1104 specifies less than 1 percent.

****OR****

B. Expanded Polystyrene (EPS) Insulation Board: ASTM C578, Type IX.

Property	Result	Test Method
Compressive Resistance	25 psi	ASTM D1621
Thermal Resistance (R-Value) @ 75 degrees F	4.2 per inch	ASTM D518 or ASTM C177
Flexural Strength	50 psi	ASTM C203
Water Vapor Permeance	2.5 perms	ASTM E96
Water Absorption	2 percent	ASTM C272
Dimensional Stability	2 percent max	ASTM D2126
Density	1.60 pcf	ASTM C303
Flame Spread	Less than 20	ASTM E84

Smoke Developed	150-300	ASTM E84

****OR****

C. Extruded Polystyrene (XPS) Insulation Board: ASTM C578, Type IV.

Property	Result	Test Method
Compressive Resistance	25 psi	ASTM D1621
Thermal Resistance (R-Value) @ 75 degrees F	5.0 per inch	ASTM D518 or ASTM C177
Flexural Strength	50 psi	ASTM C203
Water Vapor Permeance	1.5 perms	ASTM E96
Water Absorption	0.3 percent	ASTM D2842
Dimensional Stability	2 percent max	ASTM D2126
Density	1.55 pcf	ASTM C303
Maximum Use Temperature	165 degrees F	

2.7 ACCESSORIES

A. Typically for Field conditions encountered and the responsibility of the installer of Evolution 1 / Enviro-Beam Components. Evolution 1 LLC is not responsible for these conditions. The Field Installer is required to strictly adhere to Evolution 1 Installation Instructions for each individual Enviro-Component published on the envirobeam.com web site

B. Galvanic Protection: Utilize tapes and other methods as necessary to separate and prevent contact between dissimilar metals.

C. [Insulation Board Joint Tape: Dow Chemical Company, WEATHERMATE, 6 inch and 9 inch wide butyl adhesive tape, or equal and as instructed by manufacturer.]

D. [Insulation Board Gap Filler: Dow Chemical Company, FROTH-PAK, two-component, quick-cure polyurethane foam, or equal and as instructed by manufacturer.]

E. See Installation Instructions for Enviro-Roof Curbs regarding sheet metal covers for safety rail posts and exposed corner conditions.

2.8 SOURCE QUALITY CONTROL

A. Single Source Responsibility: Furnish engineered design and fabrication by or under direct responsibility of single manufacturer; Evolution 1 LLC.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify conditions ready to receive work of this Section before beginning.

3.2 PREPARATION

A. Review areas of potential interference and conflicts, and coordinate layout and support provisions for interfacing work.

3.3 INSTALLATION

A. Conform to manufacturer's instructions, ASTM C1007, and provisions of Contract Documents.

B. Strictly Adhere to Evolution 1 LLC Installation Instructions published on envirobeam.com web site for each individual Enviro-Component.

C. Touch-up shop-applied protective coatings damaged during handling and installation.

3.4 ERECTION TOLERANCES

A. Maximum Framing Member Variation from True Position: 1/8 inch.

B. Maximum Framing Member Variation from Plane:

1. Individual Framing Members: Do not exceed 1/8 inch in 10 foot.
2. Accumulative Over-all Variation for Wall and Floor System: Do not exceed 1/8 inch.

C. Conformance subject to Project Architect and General Contractor for Individual Projects

3.5 FIELD QUALITY CONTROL

A. Manufacturer’s Field Technical Service:.

1. Evolution 1 Field Technical Service available on request for site visits to be paid for by the requester, typically the General Contractor, Project Architect or the Owners Rep.

3.6 ADJUSTING

A. Inspect and adjust after installation. Replace or repair defective work.

END OF SECTION