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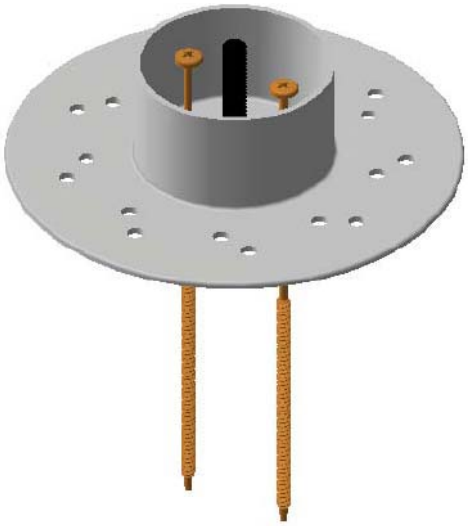
GREEN LINK ENGINEERING 3400 Covington Rd. Kalamazoo, MI 49009 USA (888) 672 - 9897

TECHNICAL INFORMATION

LOAD and UPLIFT RESISTANCE and PIPE SUPPORT INTERVALS

August 17, 2016

Knucklehead system serves two functions; in the case of load bearing it provides the necessary support and in the case of uplift it provides the necessary attachment. Table 4 summarizes Load bearing and Uplift resistance capability of Knuckleheads as they pertain to the complete roofing assembly. Ultimate compressive and tensile strength of the tough nylon Knucklehead surpasses the strength of some components of the roofing system. Suggested values in Table 4 take into consideration the following aspects and are derived based on them.



Picture 1: [P/N 2001] Universal Base and All-Purpose Fastener

Load Support

Knucklehead system is engineered to safely support equipment without compromising integrity of the roofing system. Low slope commercial roofing system minimum compressive strength is governed by the type of component found underneath the particular membrane used. In the least favorable case, cover board that protects insulation from damage is not present and polyiso insulation is in direct contact with the roofing membrane (see Table 1 for details). Derived from these values, suggested maximum allowable support load for Knucklehead Universal Base is shown in Table 4.

Table 1: Compressive Strength of polyiso insulation

Polyiso Insulation		
Test Method		ASTM C 1289
Minimum Compressive Strength	psi	16.0
	Lbs/ft2	2304.0
	kPa	110.0

Uplift Attachment

Knucklehead system is engineered to be fully adhered, mechanically fastened, both fully adhered and mechanically fastened, or it can be loose laid. In the case of loose laid application, uplift attachment is not applicable. In the case of mechanically fastened option, all-purpose screws are used to attach the Universal Base [P/N 2001] to the decking. Table 2 summarizes important pullout information on a common all-purpose fastener. In the case of fully adhered option, M-1 Structural Adhesive is used; Tensile Strength of this sub-system is

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summarized in Table 3. One should be aware that on a fully adhered Knucklehead application (omitting the use of a mechanical fastener) the uplift value is limited by the tensile strength of the weakest subsystem in a roofing assembly such as an insulation facer to insulation interface.

Picture 2: All-Purpose fasterner and M-1 adhesive

Table 2: All-purpose Fastener Specifications

All-purpose Fasterner *		
Material		SAE 1022
Thread Size	inch	0.2
	mm	6.5
Pullout in New 22 gauge Steel Deck		
Grade C	lb	360.0
	kN	1.6
Grade E	lb	400.0
	kN	1.8
Pullout in New 3/4" (19.0 mm) Plywood Deck	lb	400.0
	kN	1.8
*Firestone (W56RAC4208)		

Table 3: M-1 Structural Adhesive Specification

M-1 Structural Adhesive		
Tensile Strength*	psi	370.0
Shear Strength**	psi	390.0
*ASTM D412 **ASTM D1002		

In the case of hybrid system, fully adhered and mechanically fastened, the maximum allowable uplift force is exclusively based on pullout strength of the fastener. See Table 4 for details.

Table 4: Suggested Knucklehead Support and Uplift Resistance values.

Universal Base [P/N 2001]		
Base Diameter	in	7.0
	mm	177.8
Maximum Allowable Support Load	lbs	600.0
	kN	2.7
Maximum Allowable Uplift Force (using Faster)	lbs	720.0
	kN	3.2
Maximum Allowable Uplift Force (using Adhesive)	lbs	720.0
	kN	3.2

Pipe Support Interval

Appropriate spacing of Knucklehead assemblies to support piping will prevent many issues namely pipe sag, excessive load on pipe joints and fittings, fluid induced pipe vibrations and damage from thermal cycling. ASTM A53-86 specification for steel pipes suggests maximum allowable spacing between supports (see Table 5). Plastic piping under thermal cycling is prone to sag and proper support spacing is crucial as it can be seen in the following photograph. Refer to Table 6 for proper plastic piping support intervals.

Picture 3: Inappropriately supported PVC pipe.

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Table 5: Suggested Maximum Support Interval, Schedule 40 Steel Pipe per ASTM A53-86.

SCHEDULE 40 STEEL PIPE DATA							
Nominal Pipe Size	Pipe O.D.	Wall Thickness	Weight of Pipe	Weight of Pipe Filled with Water	**Suggested Maximum Span**	Weigth of span filled with water	Pressure on Deck (7" base = 38.5 in ^2)
In.	In.	In.	Lbs/Ft.	Lbs/Ft.	Ft.	Lbs	PSI
3/8"	0.675	0.091	0.6	0.7	**6**	4.2	0.1
1/2"	0.84	0.109	0.8	0.9	**6**	5.4	0.2
3/4"	1.05	0.113	1.1	1.3	**6**	7.8	0.2
1"	1.315	0.133	1.7	2.1	**6**	12.6	0.4
11/4"	1.66	0.14	2.3	2.9	**6**	17.4	0.5
11/2"	1.9	0.145	2.7	3.6	**9**	32.4	0.8
2"	2.375	0.154	3.6	5	**10**	50	1.3
21/2"	2.875	0.203	5.8	7.9	**11**	86.9	2.3
3"	3.5	0.216	7.6	10.8	**12**	129.6	3.4
31/2"	4	0.226	9.1	13.4	**13**	174.2	4.5
4"	4.5	0.237	10.8	16.3	**14**	228.2	5.9
5"	5.563	0.258	14.6	23.2	**16**	371.2	9.6
6"	6.625	0.28	19	31.5	**17**	535.5	13.9

SCHEDULE 80 STEEL PIPE DATA							
Nominal Pipe Size	Pipe O.D.	Wall Thickness	Weight of Pipe	Weight of Pipe Filled with Water	**Suggested Maximum Span**	Weigth of span filled with water	Pressure on Deck (7" base = 38.5 in ^2)
In.	In.	In.	Lbs/Ft.	Lbs/Ft.	**Ft.**	Lbs	PSI
3/8"	0.675	0.126	0.7	0.8	**6**	4.8	0.1
1/2"	0.84	0.147	1.1	1.2	**6**	7.2	0.2
3/4"	1.05	0.154	1.5	1.7	**6**	10.2	0.3
1"	1.315	0.179	2.2	2.5	**6**	15	0.4
11/4"	1.66	0.191	3	3.5	**6**	21	0.5
11/2"	1.9	0.2	3.6	4.3	**9**	38.7	1.0
2"	2.375	0.218	5	6.3	**10**	63	1.6
21/2"	2.875	0.276	7.6	9.4	**11**	103.4	2.7
3"	3.5	0.3	10.2	13	**12**	156	4.1
31/2"	4	0.318	12.5	16.3	**13**	211.9	5.5
4"	4.5	0.337	15	20	**14**	280	7.3
5"	5.563	0.375	20.8	28.7	**16**	459.2	11.9
6"	6.625	0.432	28.6	39.9	**15**	598.5	15.5

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Table 6: Suggested Maximum Support Interval for PVC Pipe.

PVC PIPE MAXIMUM SUPPORT INTERVAL (Ft.)										
Nominal Pipe Size In.	SCHEDULE 40					SCHEDULE 80				
	Temperature (°F)									
	60	80	100	120	140	60	80	100	120	140
1/4	4.0	3.5	3.5	2.0	2.0	4.0	4.0	3.5	2.5	2.0
3/8	4.0	4.0	3.5	2.5	2.0	4.5	4.5	4.0	2.5	2.5
1/2	4.5	4.5	4.0	2.5	2.5	5.0	4.5	4.5	3.0	2.5
3/4	5.0	4.5	4.0	2.5	2.5	5.5	5.0	4.5	3.0	2.5
1	5.5	5.0	4.5	3.0	2.5	6.0	5.5	5.0	3.5	3.0
1 1/4	5.5	5.5	5.0	3.0	3.0	6.0	6.0	5.5	3.5	3.0
1 1/2	6.0	5.5	5.0	3.5	3.0	6.5	6.0	5.5	3.5	3.5
2	6.0	5.5	5.0	3.5	3.0	7.0	6.5	6.0	4.0	3.5
2 1/2	7.0	6.5	6.0	4.0	3.5	7.5	7.5	6.5	4.5	4.0
3	7.0	7.0	6.0	4.0	3.5	8.0	7.5	7.0	4.5	4.0
3 1/2	7.5	7.0	6.5	4.0	4.0	8.5	8.0	7.5	5.0	4.5
4	7.5	7.0	6.5	4.5	4.0	9.0	8.5	7.5	5.0	4.5
5	8.0	7.5	7.0	4.5	4.0	9.5	9.0	8.0	5.5	5.0
6	8.5	8.0	7.5	5.0	4.5	10.0	9.5	9.0	6.0	5.0
8	9.0	8.5	8.0	5.0	4.5	11.0	10.5	9.5	6.5	5.5
10	10.0	9.0	8.5	5.5	5.0	12.0	11.0	10.0	7.0	6.0
12	11.5	10.5	9.5	6.5	5.5	13.0	12.0	10.5	7.5	6.5
14	12.0	11.0	10.0	7.0	6.0	13.5	13.0	11.0	8.0	7.0
16	12.5	11.5	10.5	7.5	6.5	14.0	13.5	11.5	8.5	7.5
18	13.0	12.0	11.0	8.0	7.0	14.5	14.0	12.0	11.0	9.0
20	14.0	12.5	11.5	10.0	8.5	15.5	14.5	12.5	11.5	9.5
24	15.0	13.0	12.5	11.0	9.5	17.0	15.0	14.0	12.5	10.5