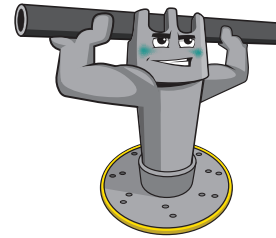


PHYSICAL PROPERTIES

KnuckleHeads are composed of injection-molded, military-grade nylon. This nylon possesses properties that make it ideal for the conditions a rooftop support must endure: the heavy weight of equipment, harsh weather cycles, continual UV exposure, seismic events, ongoing equipment vibration and even impact. Reinforced nylon is used where excellent mechanical strength, rigidity, good stability under heat and/or chemical resistance are required. The polymer lends itself well to injection molding of structural objects. It is used extensively in automotive and military applications including under-the-hood components, structural elements such as roof rack stanchions and various machine parts. **TABLE 7** summarizes typical physical properties and testing data.

Density	1.4 g/cm ³
Continuous Service Temperature	275°F
Melt Temperature	500°F
Flexural Modulus	942,745 psi
Flexural Stress	29,000 psi
Tensile Strain	5%
Tensile Stress (Break 70°F)	21,030
Tensile of Base Thread - Pullout	1,200 lbf
Tensile of Base Thread - Push Through	1,700 lbf
Tensile of Head Threads	1,000 lbf
Notched Izod Impact Strength	-22°F = 12; 70°F = 14
Water Absorption @ 70°F, 50%, R.H.	70°F, 50% R.H. = 1.7%

KNUCKLE UP!



GREEN LINK, Inc. was established to develop innovative solutions to higher performing, more sustainable construction. We focus on designing and producing innovative polymeric architectural products, which include the KnuckleHead Rooftop Support System, and related accessories. *GREEN LINK* works with contractors, architects, building owners, roofing consultants and facility managers to engineer and manufacture the best possible solutions to meet the construction challenges of the 21st century. *GREEN LINK* is committed to processes and products that cause no harm to the environment or human life.



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KnuckleHead

TECHNICAL INFORMATION

Load and Uplift Resistance | Pipe Support Intervals | Physical Properties

THE KNUCKLEHEAD SUPPORT SYSTEM SERVES CRITICAL ROOFTOP FUNCTIONS

As a load-bearing system, it delivers the necessary support for pipes, struts, pavers and related roof-mounted equipment.

As an attachment system, it provides stability under conditions of wind uplift and seismic events. The following tables summarize important data with respect to the load-bearing and uplift resistance capabilities of installed KnuckleHeads.



KnuckleHead TECHNICAL INFORMATION



LOAD SUPPORT

The KnuckleHead System is engineered to safely support pipes, heavy equipment, duct work, solar panels and other rooftop accessories. KnuckleHeads are rated to hold up to 600 lbs. each or 16 psi distributed across the base (38.5 in² area). Insulation is the weakest component in a roof system subject to compressive loads. Type II Class 2 Iso-Broad is widely used, having a compressive strength of 20 psi (**TABLE 1**). Compressive loading of 600 lbs. will not damage Iso Board or other recovery board underlayment. **TABLE 3** provides the suggested maximum allowable support load when installing KnuckleHeads.

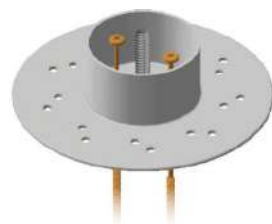


All-Purpose Fastener and Green Link Structural Adhesive/Sealant

WIND UPLIFT & ATTACHMENT

The KnuckleHead System is engineered to be mechanically fastened, fully bonded using adhesive, or both. It can also be loose laid. Under conditions where wind uplift is a factor, loose laid KnuckleHeads are not recommended. Mechanically fastened KnuckleHeads require all-purpose screws to attach the Universal Base [P/N 2001] to the decking.

TABLE 2 summarizes important pullout information on a common all-purpose fastener when used on a variety of decks. Fully adhered KnuckleHeads require the use of GreenLink Structural Adhesive/Sealant. The tensile strength of the adhesive is summarized in **TABLE 4**. 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 component in a roofing assembly such as an insulation facer-to-insulation interface. A hybrid system uses both mechanical fasteners and adhesives. In this case, the maximum allowable uplift force is based solely on the pullout strength of the fastener. See **TABLE 3** for details. In the case of a hybrid system, fully adhered and mechanically fastened, the maximum allowable wind uplift force is exclusively based on pullout strength of the fastener. See **TABLE 3** for details.



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

PIPE SUPPORT INTERVAL

Proper spacing of KnuckleHead assemblies to support piping will prevent problems caused by pipe sag, excessive load on joints and fittings, fluid-induced pipe vibrations and damage from thermal cycling. ASTM A53-86 specification for steel pipes suggests the maximum allowable spacing between supports (see **TABLE 5**). Plastic piping exposed to thermal cycling is prone to sag, and proper support spacing is crucial. The photo to the left shows pipe sag issues resulting from improper spacing. Refer to **TABLE 6** for proper plastic piping support intervals.



Pipe Sag

TABLE 1

Compressive Strength of Polyiso Insulation

POLYISO INSULATION -TYPE II CLASS 2		
Test Method	ASTM C 1289	
Minimum Compressive Strength	PSI	20.0
	lbs./ft. ²	2304.0
	kPa	138.0

TABLE 3

Suggested KnuckleHead Support & Uplift Resistance Values (per unit)

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 Fastener)	lbs.	720
	kN	3.2
Maximum Allowable Uplift Force (Using Adhesive) <i>See wind Uplift & Attachment Section</i>	lbs.	800.0
	kN	3.56

TABLE 5

Suggested Maximum Support Interval per ASTM A53-86

Nominal Pipe Size	SCHEDULE 40 STEEL PIPE DATA								SCHEDULE 80 STEEL PIPE DATA							
	Pipe O.D.	Wall Thickness	Weight of Pipe	Weight of Pipe Filled with Water	Suggested Maximum Span	Weight of Span Filled with Water	Pressure on Deck	Pipe O.D.	Wall Thickness	Weight of Pipe	Weight of Pipe Filled with Water	Suggested Maximum Span	Weight of Span Filled with Water	Pressure on Deck		
	In.	In.	Lbs./Ft.	Lbs./Ft.	Ft.	Lbs.	PSI	In.	In.	Lbs./Ft.	Lbs./Ft.	Ft.	Lbs.	PSI		
3/8"	0.675	0.091	0.6	0.7	7	4.2	0.1	0.675	0.126	0.7	0.8	7	4.8	0.1		
1/2"	0.84	0.109	0.8	0.9	7	5.4	0.2	0.84	0.147	1.1	1.2	7	7.2	0.2		
3/4"	1.05	0.113	1.1	1.3	7	7.8	0.2	1.05	0.154	1.5	1.7	7	10.2	0.3		
1"	1.315	0.133	1.7	2.1	7	12.6	0.4	1.315	0.179	2.2	2.5	7	15	0.4		
1 1/4"	1.66	0.14	2.3	2.9	7	17.4	0.5	1.66	0.191	3	3.5	7	21	0.5		
1 1/2"	1.9	0.145	2.7	3.6	9	32.4	0.8	1.9	0.2	3.6	4.3	9	38.7	1.0		
2"	2.375	0.154	3.6	5	10	50	1.3	2.375	0.218	5	6.3	10	63	1.6		
2 1/2"	2.875	0.203	5.8	7.9	11	86.9	2.3	2.875	0.276	7.6	9.4	11	103.4	2.7		
3"	3.5	0.216	7.6	10.8	12	129.6	3.4	3.5	0.3	10.2	13	12	156	4.1		
3 1/2"	4	0.226	9.1	13.4	13	174.2	4.5	4	0.318	12.5	16.3	13	211.9	5.5		
4"	4.5	0.237	10.8	16.3	14	228.2	5.9	4.5	0.337	15	20	14	280	7.3		
5"	5.563	0.258	14.6	23.2	16	371.2	9.6	5.563	0.375	20.8	28.7	16	459.2	11.9		
6"	6.625	0.28	19	31.5	17	535.5	13.9	6.625	0.432	28.6	39.9	17	598.5	15.5		

TABLE 2

All-purpose Fastener Specifications

ALL-PURPOSE FASTENER		
Material	SAE 1022	
Thread Size	In.	0.2
PULLOUT		
New 22 Gauge Steel Deck	lbs.	800.0
	kN	3.56
New 3/4" (19 mm) Wood	lbs.	400.0
	kN	1.8

TABLE 4

GREEN LINK ADHESIVE/SEALANT

Tensile Strength*	PSI	370.0
Shear Strength**	PSI	390.0

*ASTM D412
**ASTM D1002

TABLE 6

Suggested Maximum Support Interval (ft.)

Nominal Pipe Size In.	SCHEDULE 40 PVC PIPE					SCHEDULE 80 PVC PIPE				
	Temperature (°F)					Temperature (°F)				
	60°	80°	100°	120°	140°	60°	80°	100°	120°	140°
1/4	4	3.5	3.5	2	2	4	4	3.5	2.5	2
3/8	4	4	3.5	2.5	2	4.5	4.5	4	2.5	2.5
1/2	4.5	4.5	4	2.5	2.5	5	4.5	4.5	3	2.5
3/4	5	4.5	4	2.5	2.5	5.5	5	4.5	3	2.5
1	5.5	5	4.5	3	2.5	6	5.5	5	3.5	3
1 1/4	5.5	5.5	5	3	3	6	6	5.5	3.5	3
1 1/2	6	5.5	5	3.5	3	6.5	6	5.5	3.5	3.5
2	6	5.5	5	3.5	3	7	6.5	6	4	3.5
2 1/2	7	6.5	6	4	3.5	7.5	7.5	6.5	4.5	4
3	7	7	6	4	3.5	8	7.5	7	4.5	4
3 1/2	7.5	7	6.5	4	4	8.5	8	7.5	5	4.5
4	7.5	7	6.5	4.5	4	9	8.5	7.5	5	4.5
5	8	7.5	7	4.5	4	9.5	9	8	5.5	5
6	8.5	8	7.5	5	4.5	10	9.5	9	6	5
8	9	8.5	8	5	4.5	11	10.5	9.5	6.5	5.5
10	10	9	8.5	5.5	5	12	11	10	7	6
12	11.5	10.5	9.5	6.5	5.5	13	12	10.5	7.5	6.5
14	12	11	10	7	6	13.5	13	11	8	7
16	12.5	11.5	10.5	7.5	6.5	14	13.5	11.5	8.5	7.5
18	13	12	11	8	7	14.5	14	12	11	9
20	14	12.5	11.5	10	8.5	15.5	14.5	12.5	11.5	9.5
24	15	13	12.5	11	9.5	17	15	14	12.5	10.5