

Wire Rope SWL - Selection, D/d Ratio & Sling Hitches

Rope SWL, shackle selection, D/d bend ratio, hitch factors, synthetic vs wire rope. Minimum Breaking Force (MBF) · Safe Working Load (SWL) · Working Load Limit (WLL) · Design Factor (5:1) · Leg Tension (T) · Sling Angle from Horizontal (α) · Bend and Rope Diameter (D, d)

SAFE WORKING LOAD

$$SWL = MBF / 5$$

Rope: $SWL \geq T$ Shackle: $WLL \geq T$

Vertical capacity per leg = $SWL \cdot \sin \alpha$ α from horizontal

MBF is a published rope property, read from the tables on sheet 02-2, never calculated. 5:1 is the usual design factor for wire rope slings. A shackle is not derived: it carries the manufacturer's stamped WLL. Strength runs IPS < EIPS < EEIPS; IWRC beats fiber core at the same diameter.

WORKED EXAMPLE: 3/4 IN, 6×19 IWRC, EIPS

Given: T required = 11,000 lb per leg, 2-leg pick at $\alpha = 60^\circ$

1. MBF = 58,800 lbf (sheet 02-2, IWRC · EIPS · 3/4 in)
2. $SWL = 58,800 / 5 = 11,760 \text{ lb} \geq 11,000 \text{ lb}$
3. Vertical per leg = $11,760 \times \sin 60^\circ = 10,185 \text{ lb}$; two legs = 20,369 lb
4. Shackle: 3/4 in WLL 10,472 lb < T → use 7/8 in, WLL 14,330 lb

Same pair at 30° : $11,760 \times \sin 30^\circ \times 2 = 11,760 \text{ lb}$. Sling angle halves the usable lift.

D/D RATIO: HOW HARD THE ROPE IS BENT

$$D/d = D / d$$

D = diameter of the surface the rope bends around (pin, hook, sheave). d = nominal rope diameter. Larger D/d, gentler bend. Smaller D/d, more bending stress on the wires and less rope efficiency.

Example: 3/4 in 6×19 eye-and-eye sling, no thimble, eye over a 3/4 in shackle pin (≈ 0.88 in)

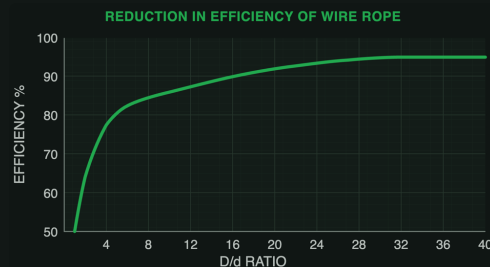
1. $D/d = 0.88 / 0.75 = 1.17$
2. Published sling ratings are commonly based on 25:1

The shackle WLL checks out. The sling does not keep its published capacity at $D/d = 1.17$. Separate ratings; the connection geometry controls.

- **Thimbles change the connection.** A properly sized thimble gives the eye a larger, controlled bearing surface. Consider a thimble where the eye connects directly to shackles, hooks, or master links, especially on repeat use.
- **Fixes:** larger-radius pin, hook or sheave; a thimble; a manufacturer-rated sling/shackle pairing; or a rated synthetic sling where the geometry forces a small radius.

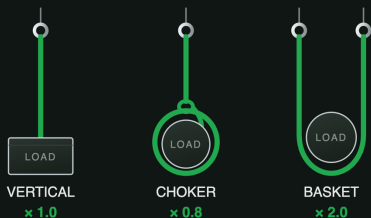
D/D IN PRACTICE

- **No generic reduction factor.** Efficiency at small D/d depends on construction, grade, termination, and contact geometry. Use manufacturer data or a qualified person, not $MBF \times$ a guessed factor. The curve below is illustrative only, not design data.
- **Unthimble eye-and-eye slings** are made for basket and choker hitches, where the sling body wraps the load. In a vertical hitch, keep the bare eye off small pins.



Illustrative only. Shape of the trend, not manufacturer efficiency data.

SLING HITCH TYPES & CAPACITY



HITCH	TYPICAL FACTOR	RELATIVE TO RATED VERTICAL CAPACITY
Vertical	1.00×	One vertical leg supports the load.
Basket	2.00×	Two portions of the sling carry the load.
Choker	0.75–0.80×	Sling passed around the load and choked.

Basket and choker factors are typical values, not universal ratings. Factors assume vertical legs; angled rigging reduces capacity further. Manufacturer's published rating for the specific configuration governs.

SYNTHETIC VS WIRE ROPE SLINGS

Synthetic (round and flat/web) slings are light, flexible, easy to handle, and kind to finished surfaces; round slings conform best, web slings position easily. Wire rope is heavier and stiffer but stands up to abrasion, rough handling, and heat, so it carries most heavy construction picks.

	SYNTHETIC	WIRE ROPE
Weight	Light	Heavy
Flexibility	Excellent	Moderate
Surface protection	Excellent	Lower
Abrasion / cut resistance	Lower	Higher
Heat resistance	Lower	Higher
Best suited for	Finished, irregular, lighter loads	Heavy, rough, abrasive work

Synthetics cut, abrade, and heat-damage easily; protect every edge. Wire rope can mark load surfaces and needs inspection for broken wires, kinks, and corrosion.

FIELD NOTES

- **Straight vertical pull.** One leg loaded straight down. Angled or multi-leg picks raise tension; derate with $SWL \cdot \sin \alpha$. See Quick Ref-01.
- **Static, as-new rope.** No shock, swing, or impact factor. Fast picks and unequal legs push real tension higher; add margin.
- **5:1 is typical, not universal.** Some owners and jurisdictions specify higher. Confirm with the rigging manufacturer first.
- **Terminations govern.** A clip assembly develops roughly 80% of rope strength; a poured or swaged socket close to 100%.
- **Inspect before and after use.** Broken wires, kinks, bird-caging, crushing, or corrosion: out of service immediately.
- **Extra caution with synthetics.** More open to cuts, abrasion, UV, heat, and chemicals than wire rope. Pad every edge; inspect before use.

Wire Rope SWL - 6×19 Breaking Force & Shackle Tables

Weight and minimum breaking force for 6×19 wire rope, 1/4 to 2-1/4 in, FC and IWRC, three grades, plus shackle working load limits. Improved Plow Steel (IPS) · Extra Improved Plow Steel (EIPS) · Extra Extra Improved Plow Steel (EEIPS) · Fiber Core (FC) · Independent Wire Rope Core (IWRC)

6×19 WIRE ROPE · WEIGHT (LB/FT) AND MINIMUM BREAKING FORCE (MBF), LBF AND METRIC TONS (T)

DIA (IN)	FIBER CORE (FC)								STEEL CORE (IWRC)							
	WEIGHT		IPS		EIPS		EEIPS		WEIGHT		IPS		EIPS		EEIPS	
	LB/FT		LBF	T	LBF	T	LBF	T	LB/FT		LBF	T	LBF	T	LBF	T
1/4	0.11		5,480	2.49	6,020	2.73	—	—	0.12		5,880	2.67	6,800	3.08	—	—
5/16	0.16		8,520	3.86	9,380	4.25	—	—	0.18		9,160	4.15	10,540	4.78	—	—
3/8	0.24		12,200	5.53	13,420	6.09	14,760	6.70	0.26		13,120	5.95	15,100	6.85	16,600	7.53
7/16	0.32		16,540	7.50	18,200	8.26	20,020	9.08	0.35		17,780	8.06	20,400	9.25	22,400	10.2
1/2	0.42		21,400	9.71	23,600	10.7	25,800	11.7	0.46		23,000	10.4	26,600	12.1	29,200	13.2
9/16	0.53		27,000	12.2	29,800	13.5	32,600	14.8	0.58		29,000	13.2	33,600	15.2	37,000	16.8
5/8	0.66		33,400	15.2	36,800	16.7	40,400	18.3	0.72		35,400	16.1	41,200	18.7	45,400	20.6
3/4	0.95		47,600	21.6	52,400	23.8	57,600	26.1	1.04		51,200	23.2	58,800	26.7	64,800	29.4
7/8	1.29		64,400	29.2	70,800	32.1	78,000	35.4	1.41		69,200	31.4	79,600	36.1	87,600	39.7
1	1.68		83,600	37.9	92,000	41.7	101,200	45.9	1.85		89,800	40.7	103,400	46.9	113,800	51.6
1-1/8	2.13		105,200	47.7	115,800	52.5	127,200	57.7	2.34		113,000	51.3	130,000	59.0	143,000	64.9
1-1/4	2.63		129,200	58.6	142,200	64.5	156,400	70.9	2.89		138,800	63.0	159,800	72.5	175,800	79.7
1-3/8	3.18		155,400	70.5	171,000	77.6	188,000	85.3	3.49		167,000	75.8	192,000	87.1	212,000	96.2
1-1/2	3.78		184,000	83.5	202,400	91.8	222,600	101.0	4.16		197,800	89.7	228,000	103.4	250,000	113.4
1-5/8	4.44		214,000	97.1	236,000	107.0	258,000	117.0	4.88		230,000	104.3	264,000	119.7	292,000	132.4
1-3/4	5.15		248,000	112.5	272,000	123.4	300,000	136.1	5.66		266,000	120.7	306,000	138.8	338,000	153.3
1-7/8	5.91		282,000	127.9	310,000	140.6	342,000	155.1	6.49		304,000	137.9	348,000	157.9	384,000	174.2
2	6.73		320,000	145.1	352,000	159.7	388,000	176.0	7.39		344,000	156.0	396,000	179.6	434,000	196.9
2-1/8	7.60		358,000	162.4	394,000	178.7	434,000	196.9	8.34		384,000	174.2	442,000	200.5	486,000	220.4
2-1/4	8.52		400,000	181.4	440,000	199.6	484,000	219.5	9.35		430,000	195.0	494,000	224.1	544,000	246.8



6×19 IWRC section shown. MBF only. SWL = MBF / 5 at a 5:1 design factor; angled legs SWL · sin α. Pick core and grade from the rope tag or cert first, then read across to the diameter: 3/4 in runs from 47,600 lbf (FC IPS) to 64,800 lbf (IWRC EEIPS), a 36% spread, so never size by diameter alone. Rope SWL, not sling WLL: termination efficiency is not applied, the fabricator's tagged WLL governs a finished sling. Metric tons at 2,204.62 lb/t. — : not produced in that grade. Selection example and D/d on sheet 02-1.

CARBON STEEL SHACKLES · WLL AND ULTIMATE, LB AND METRIC TONS (T)

SIZE (IN)	WLL		ULTIMATE		SIZE (IN)	WLL		ULTIMATE	
	LB	T	LB	T		LB	T	LB	T
3/16	735	0.33	4,409	2	1-1/8	20,944	9.5	125,663	57
1/4	1,102	0.5	6,614	3	1-1/4	26,455	12	158,733	72
5/16	1,653	0.75	9,921	4.5	1-3/8	29,762	13.5	178,574	81
3/8	2,205	1	13,228	6	1-1/2	37,479	17	224,871	102
7/16	3,307	1.5	19,842	9	1-3/4	55,116	25	330,693	150
1/2	4,409	2	26,455	12	2	77,162	35	462,970	210
5/8	7,165	3.25	42,990	19.5	2-1/2	121,254	55	727,525	330
3/4	10,472	4.75	62,832	28.5	3	187,393	85	1,124,356	510
7/8	14,330	6.5	85,980	39	3-1/2	264,554	120	1,587,326	720
1	18,739	8.5	112,436	51	4	330,693	150	1,984,158	900



Manufacturer's stamped WLL, carried as published. The 3/4 in shackle shown is stamped WLL 4-3/4 t (10,472 lb). The 5:1 factor is not applied to shackles in either direction.