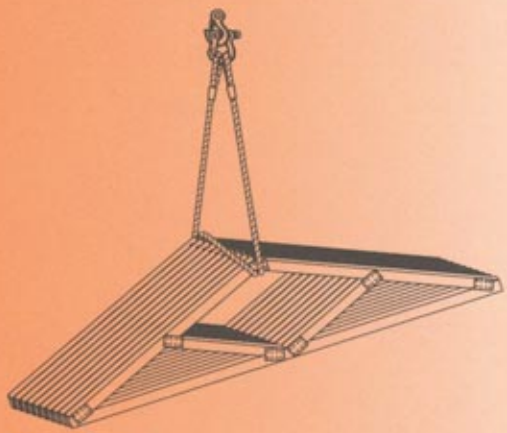
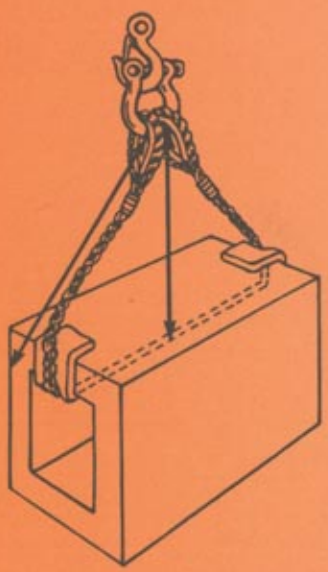
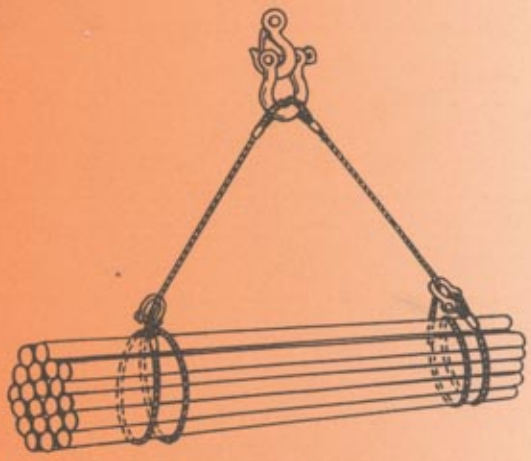
CONSTRUCTION SAFETY







Slings

In the past, members of the public have used printed information that was outdated by subsequent improvements in knowledge and technology. We therefore make the following statement for their protection in future.

The information presented here was, to the best of our knowledge, current at time of printing and is intended for general application. This publication is not a definitive guide to government regulations or to practices and procedures wholly applicable under every circumstance. The appropriate regulations and statutes should be consulted. Although the Construction Safety Association of Ontario cannot guarantee the accuracy of, nor assume liability for, the information presented here, we are pleased to answer individual requests for counselling and advice.

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CONTENTS

SLING CONFIGURATIONS

The term "sling" covers a wide variety of configurations for fibre ropes, wire ropes, chains, and webs. Correct application of slings commonly used in construction will be explained here because improper application can be dangerous.

The **Single Vertical Hitch** (Figure 1) supports a load by a single vertical part or leg of the sling. The total weight of the load is carried by a single leg, the sling angle is 90° (sling angle is measured from the horizontal), and the weight of the load can equal the maximum working load limit of the sling and fittings. End fittings can vary but thimbles should be used in the eyes. The eye splices on wire ropes should be Mechanical-Flemish Spices for best security.

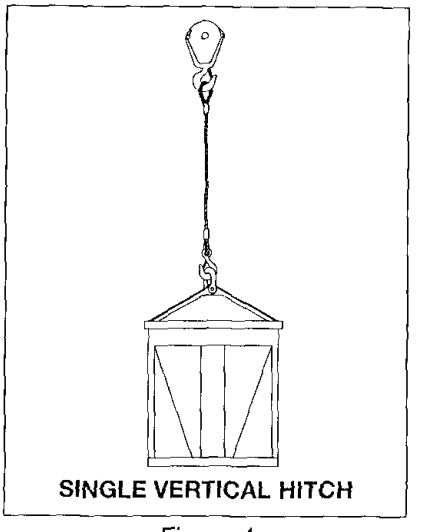


Figure 1

The single vertical hitch must not be used for lifting loose material, lengthy material, or anything difficult to balance. This hitch provides absolutely no control over the load because it permits rotation. Use single vertical hitches only on items equipped with lifting eyebolts or shackles.

Bridle Hitch (Figures 2,3,4). Two or more single hitches can be used together to form a bridle hitch for hoisting an object with the necessary lifting lugs or attachments. Used with a wide assortment of end fittings, bridle hitches provide excellent load stability when the load is distributed equally among the legs. the hook is directly over the load's centre of gravity, and the load is raised level. To distribute the load equally it may be necessary to adjust the leg lengths with turnbuckles. Proper use of a bridle hitch requires that sling angles be carefully measured to ensure that individual legs are not overloaded.

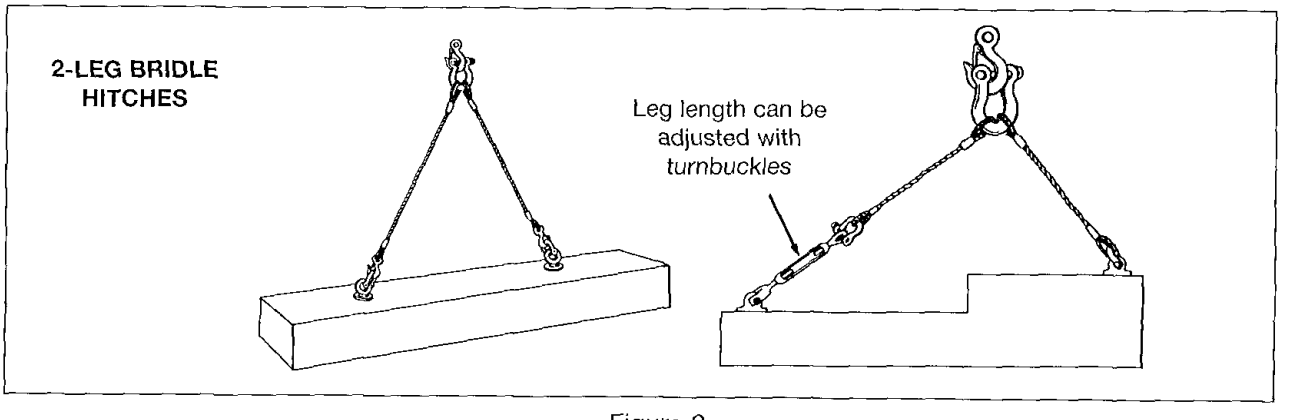


Figure 2

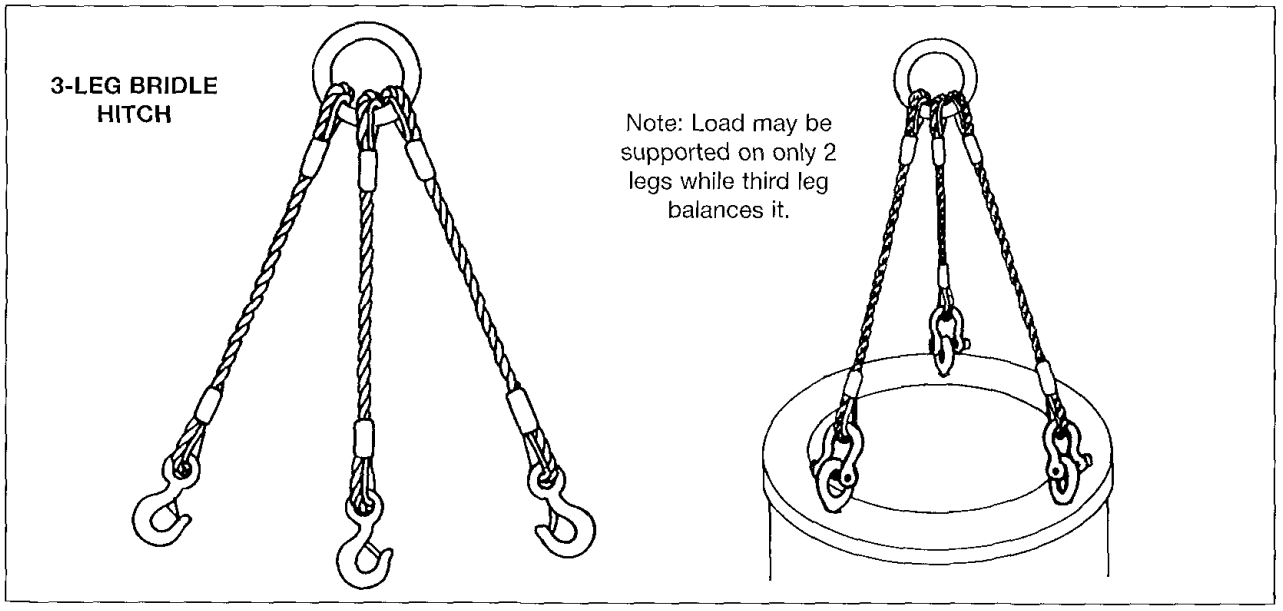


Figure 3

Because the load may not be distributed evenly when a four-leg sling lifts a rigid load, assume that the load is carried by two or three of the legs only and "rate" the four-leg sling as a two-leg sling.

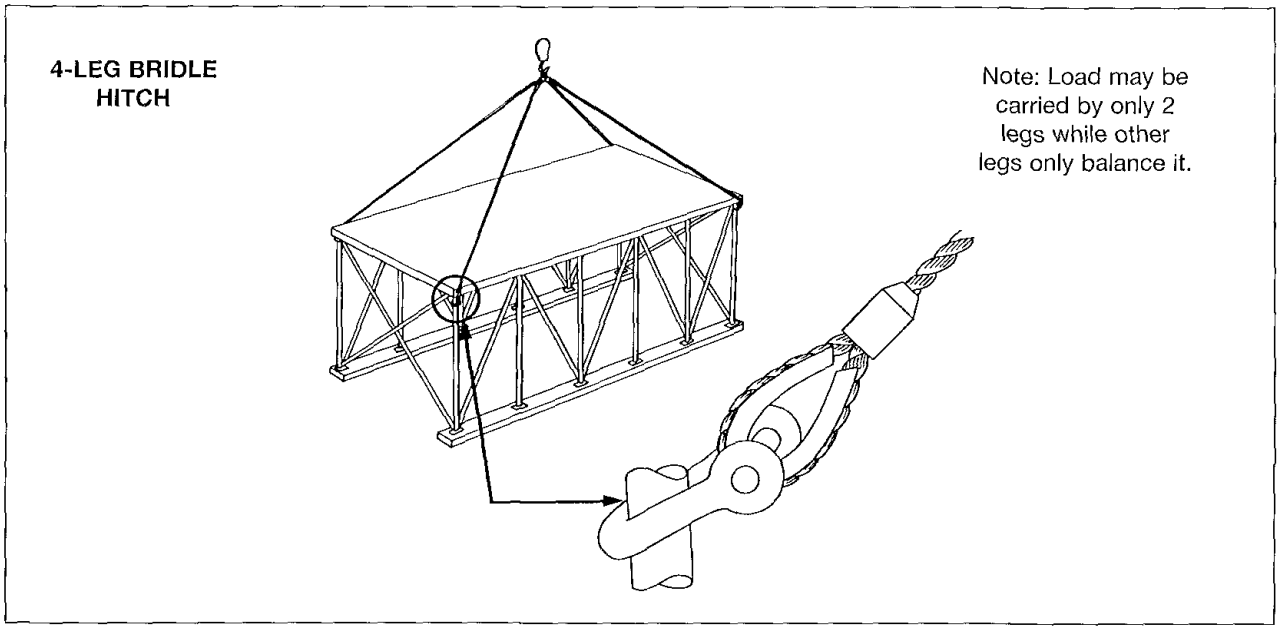


Figure 4

The **Single Basket Hitch** (Figure 5) is used to support a load by attaching one end of the sling to the hook, then passing the other end under the load and attaching it to the hook. Ensure that the load does not turn or slide along the rope during a lift because both load and rope can be damaged.

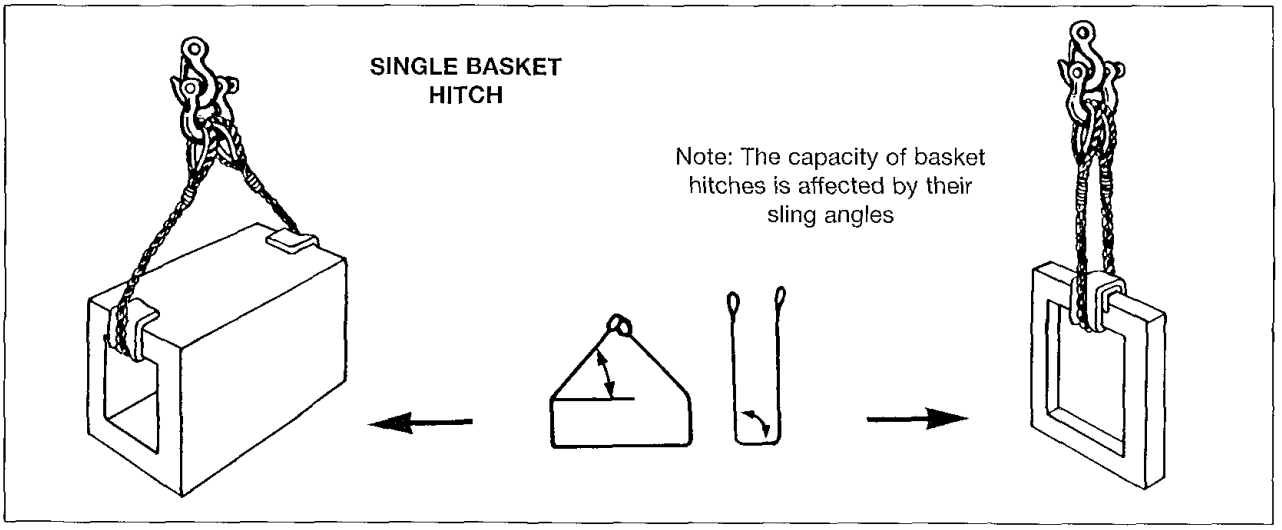


Figure 5

The **Double Basket Hitch** (Figure 6) consists of two single basket hitches passed under the load. They must be placed under the load so that it is balanced. The legs of the hitches must be kept far enough apart to provide balance but not so far apart that low angles are created and the legs pull in toward the centre. The angle between the load and the sling should be approximately 60° or greater to avoid slippage. On smooth surfaces, both sides of the hitch should be snubbed against a change of contour to prevent the rope from slipping as load is applied. Otherwise use a double wrap basket hitch.

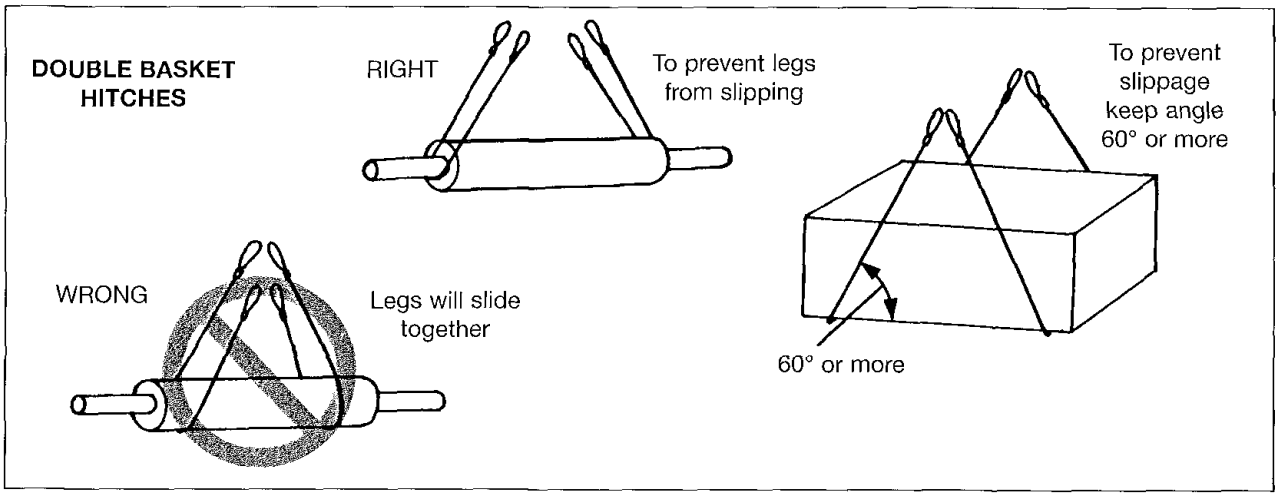


Figure 6

The **Double Wrap Basket Hitch** (Figure 7) is a basket hitch wrapped completely around the load and compressing it rather than merely supporting it, as does the ordinary basket hitch. The double wrap basket hitch can be used in pairs like the double basket hitch. This method is excellent for handling loose material, pipe, rod, or smooth cylindrical loads because the sling is in full 360° contact with the load and tends to draw it together.

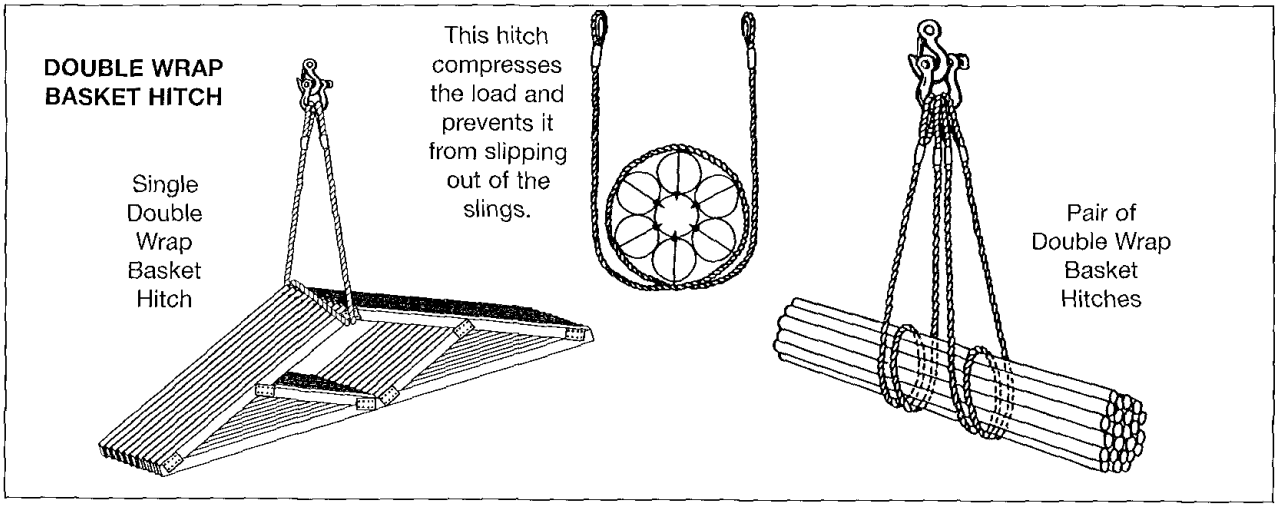


Figure 7

The **Single Choker Hitch** (Figure 8) forms a noose in the rope. It does not provide full 360° contact with the load, however, and therefore should not be used to lift loads difficult to balance or loosely bundled. The single choker can also be doubled up to provide twice the capacity or to turn a load. (Doubling a single choker hitch is not the same as using a double choker hitch.)

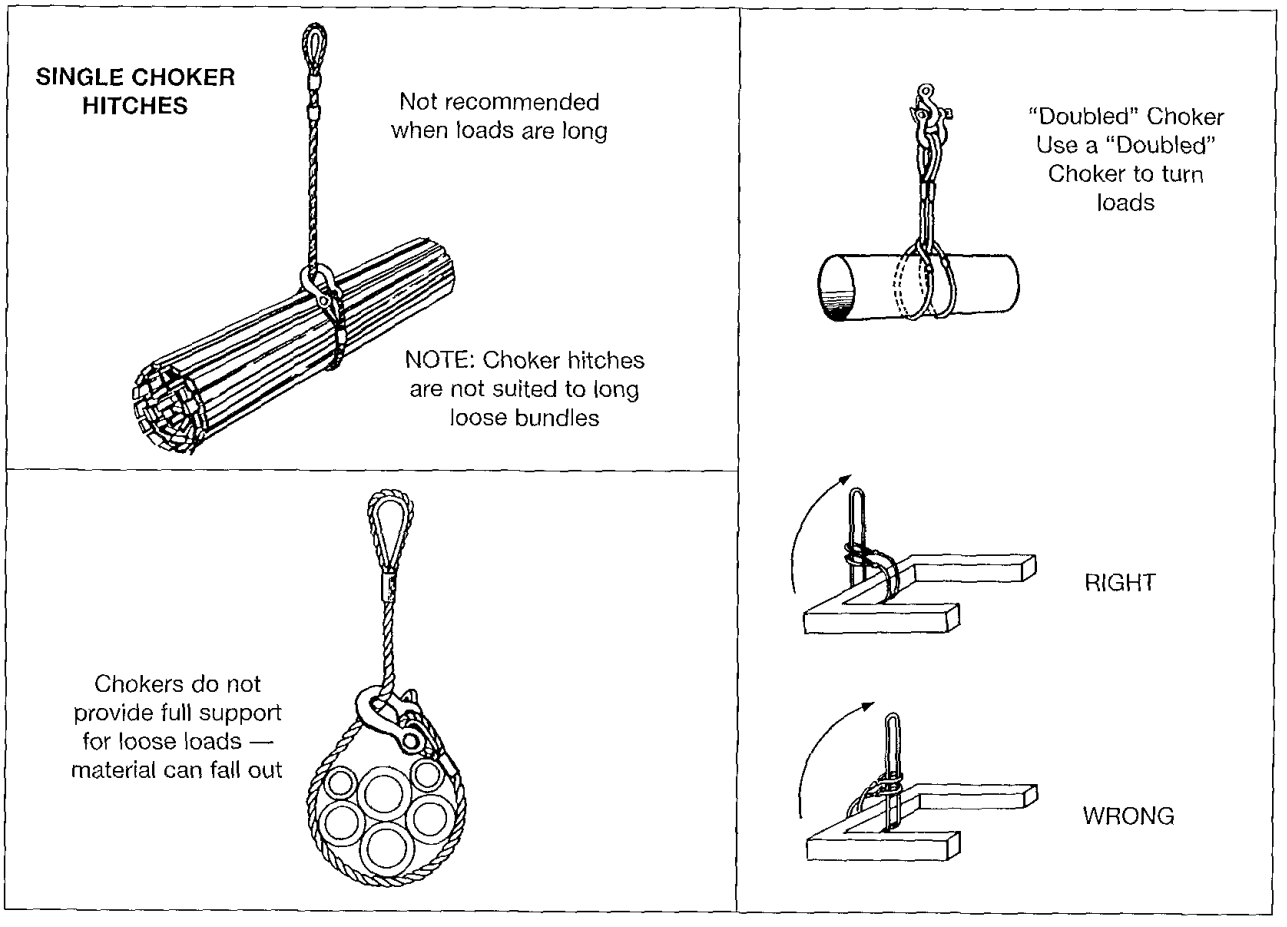


Figure 8

When it is necessary to turn a load, the choker is made by placing both eyes of the sling on top of the load with the eyes pointing opposite to the direction of the turn. The centre of the sling is passed around the load, through both eyes, and up to the hook. This hitch provides complete control over the load during the entire turning operation, and the load automatically equalizes between the two supporting legs of the sling.

The **Double Choker Hitch** (Figure 9) consists of two single chokers attached to the load and spread to provide load stability. Like the single choker, the double choker does not completely grip the load. But because the load is less likely to tip, the double choker is better suited to handling loosely bundled items.

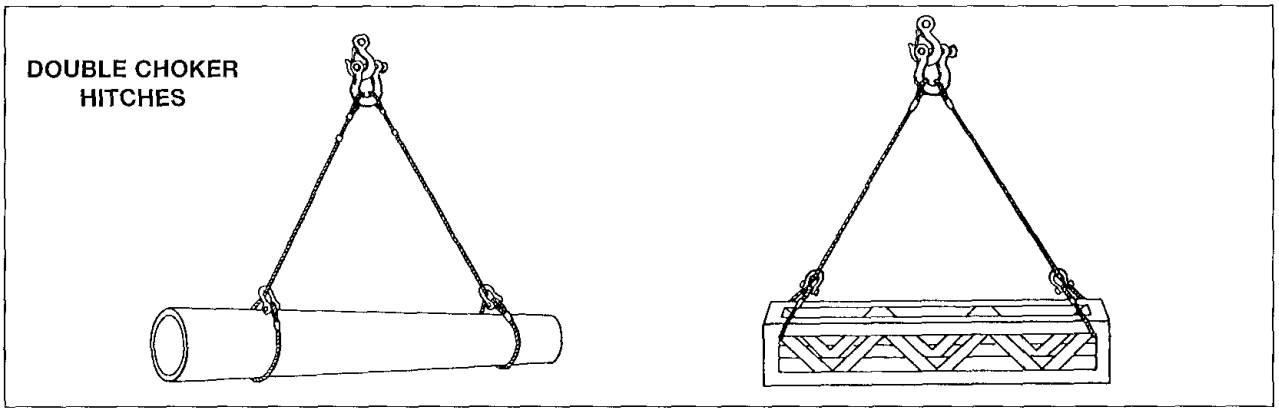


Figure 9

A **Double Wrap Choker Hitch** (Figure 10) is formed by wrapping the sling completely around the load and hooking it into the vertical part of the sling. This hitch is in full 360° contact with the load and tends to draw it tightly together. It can be used either singly on short, easily balanced loads or in pairs on longer loads.

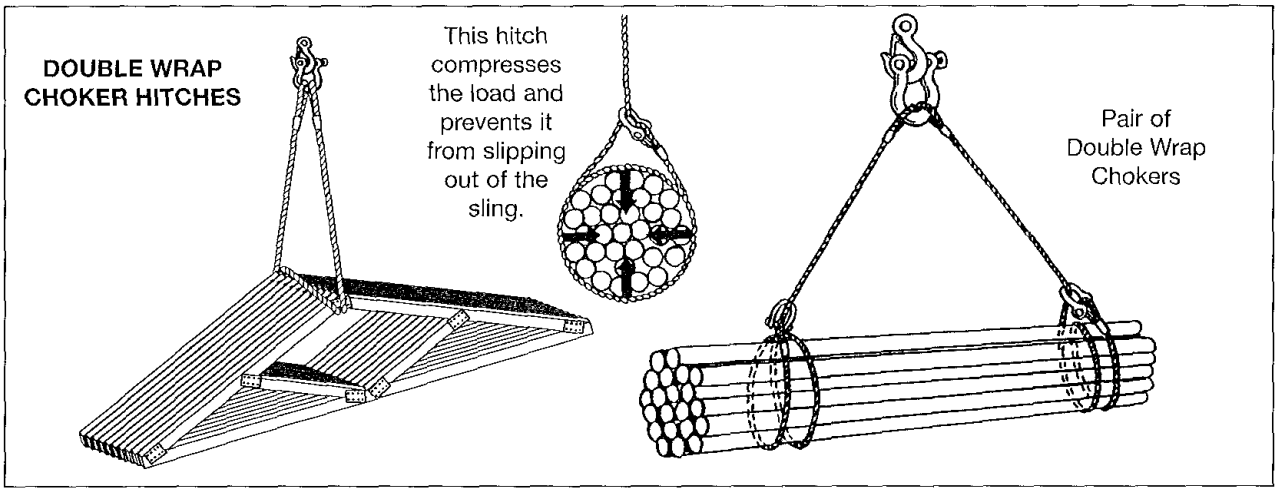


Figure 10

Endless Slings or Grommet Slings (Figure 11) are useful for a variety of applications. Endless chain slings are manufactured by attaching the ends of a length of chain with a welded or mechanical link. Endless web slings are sewn. Another variety of endless sling is the "round sling." An endless wire rope sling is made from one continuous strand wrapped onto itself to form a six-strand rope with a strand core. The end is tucked into the body at the point where the strand was first laid onto itself. These slings can be used in a number of configurations, as vertical hitches, basket hitches, choker hitches, and combinations of these basic arrangements. They are very flexible but tend to wear more rapidly than other slings because they are not normally equipped with fittings and thus are deformed when bent over hooks or choked.

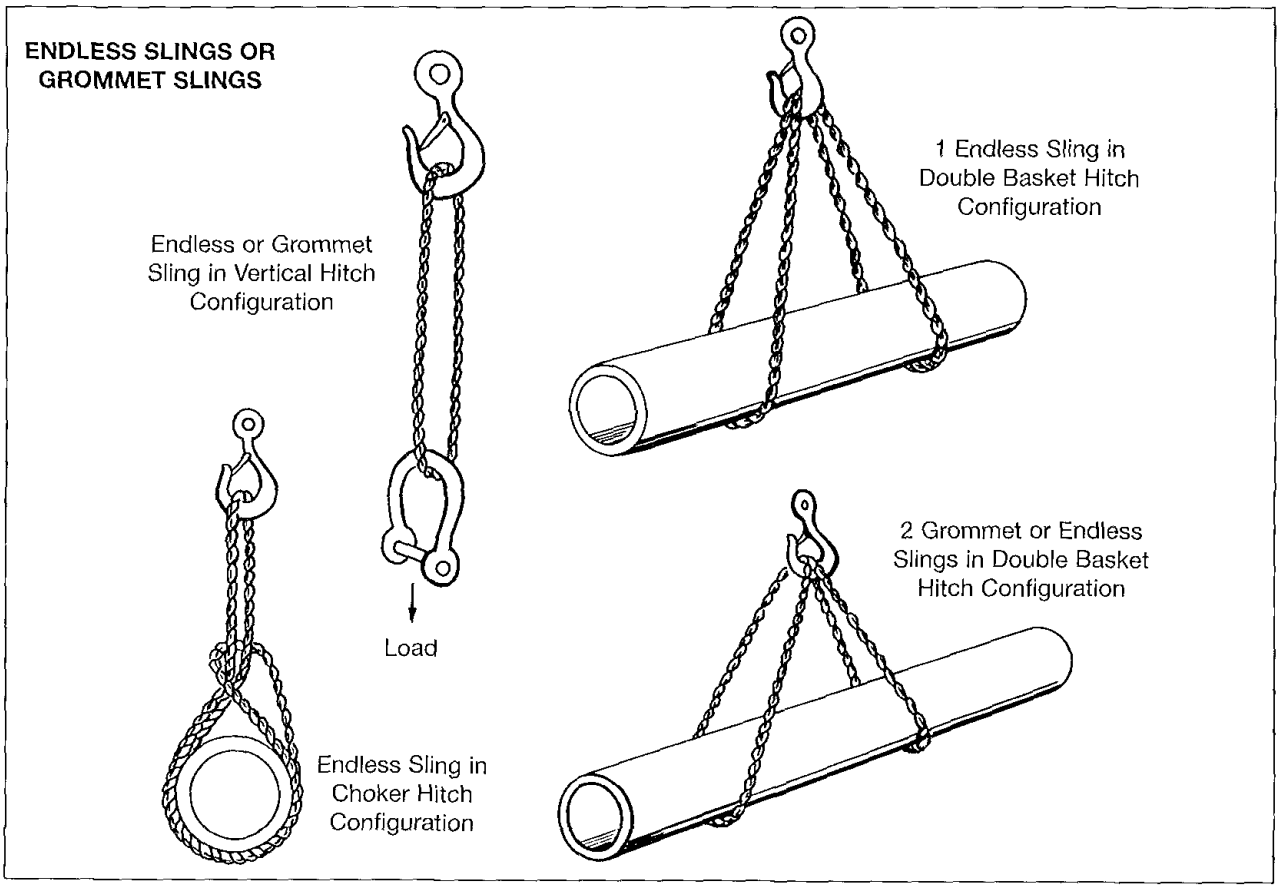


Figure 11

Braided Slings (Figure 12) are usually fabricated from six to eight small-diameter ropes braided together to form a single rope that provides a large bearing surface, tremendous strength, and flexibility in every direction. They are easy to handle and almost impossible to kink. The braided sling can be used in all the standard configurations and combinations but is especially useful for basket hitches where low bearing pressure is desirable or where the bend is extremely sharp.

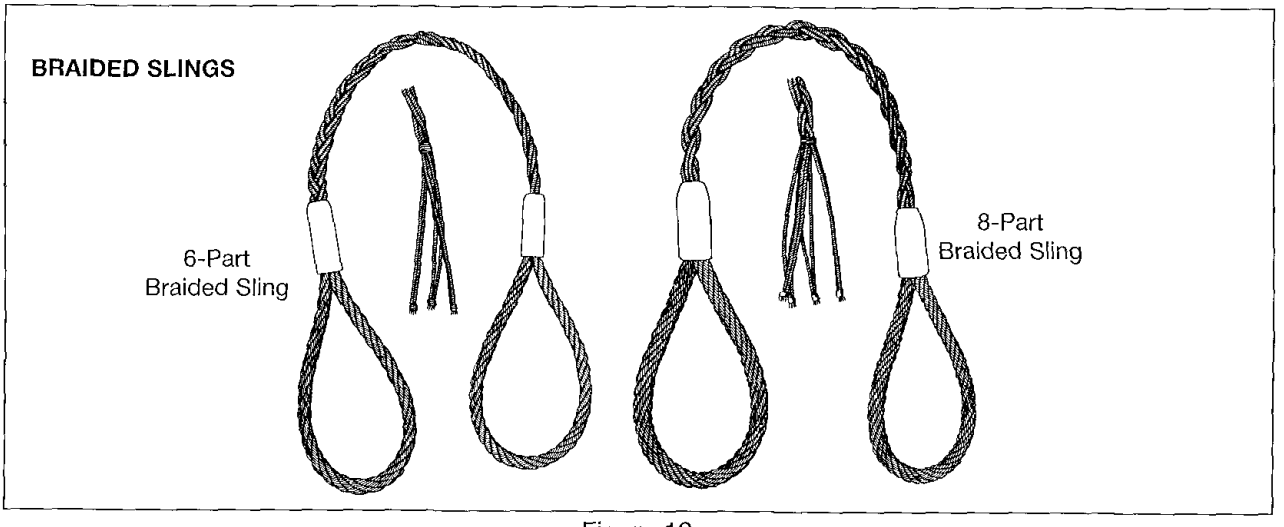


Figure 12

SLING ANGLES

The loading in any type of sling is affected by the angle of the legs. If possible, keep leg angles greater than 45° from the horizontal. Sling angles approaching 30° are extremely hazardous and must be avoided at all costs. The sharp increase in loading at low angles is clearly shown in Figure 13.

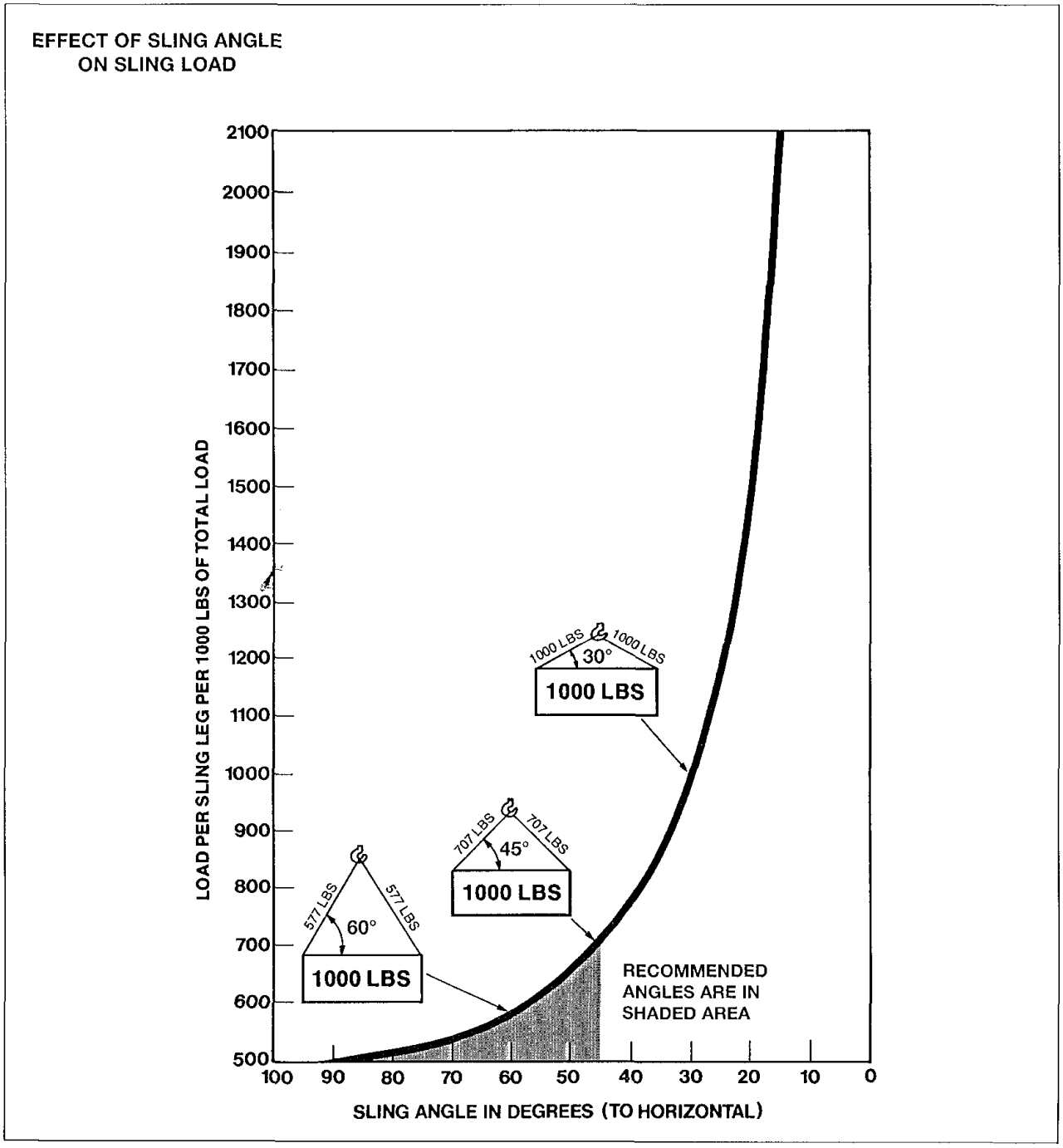


Figure 13

Low sling angles also create large, horizontal compressive forces in the load which may be sufficient to cause buckling, especially in long, flexible loads.

Some load tables list sling angles as low as 15° but the use of any sling at an angle less than 30° greatly reduces capacity and is not recommended. Not only are the loads in each leg high at these low angles but an error in measurement as little as 5° can affect the load in the sling drastically. Table 1 illustrates the effect of a 5° error in angle measurement on the sling load. Notice that there is a 50% error in the assumed load at the 15° sling angle.

Table 1

EFFECT OF SLING ANGLE MEASUREMENT ERROR ON LOADS				
Assumed Sling Angle	Assumed Load (Pounds per Leg)	Actual Angle (is 5° less than Assumed Angle)	Actual Load (Pounds per Leg)	Error %
90°	500	85°	502	0.4
75°	518	70°	532	2.8
60°	577	55°	610	5.7
45°	707	40°	778	9.1
30°	1,000	25°	1,183	18.3
15°	1,932	10°	2,880	49.0

The diagram below shows how the loads on sling legs increase as the sling angle decreases.

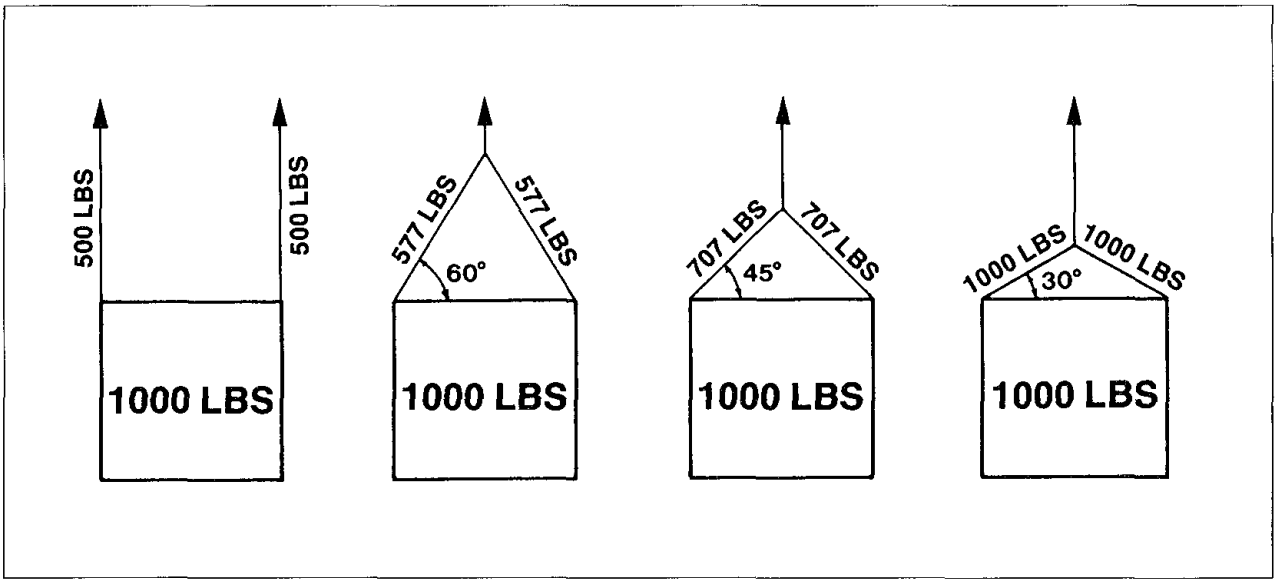


Figure 13a

WORKING LOAD LIMITS

Sling Angle and WLL

Sling angles are crucial in determining working load limits (WLL) for many sling configurations. In tables of working load limits, capacities are given for bridle and basket hitches at angles of 60°, 45°, and 30°. Measuring these angles can be difficult on a construction site since the measuring tools required are generally not available.

There are, however, two angles which you can easily determine before consulting tables. The first is a 90° angle formed by two legs of a bridle or basket hitch at the crane hook or master link (Figure 14). This corresponds to a 45° sling angle.

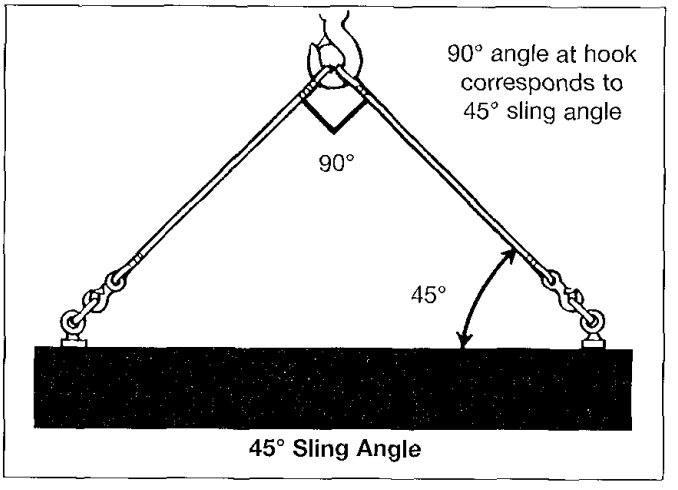


Figure 14

The second angle easy to identify is a 60° sling angle (Figure 15). For a bridle hitch, a 60° sling angle can be recognized when the distance between the attachment points is equal to the length of a sling leg; for a basket hitch, when the distance between the points at which the sling first contacts the load is equal to the length of one inclined leg of the sling.

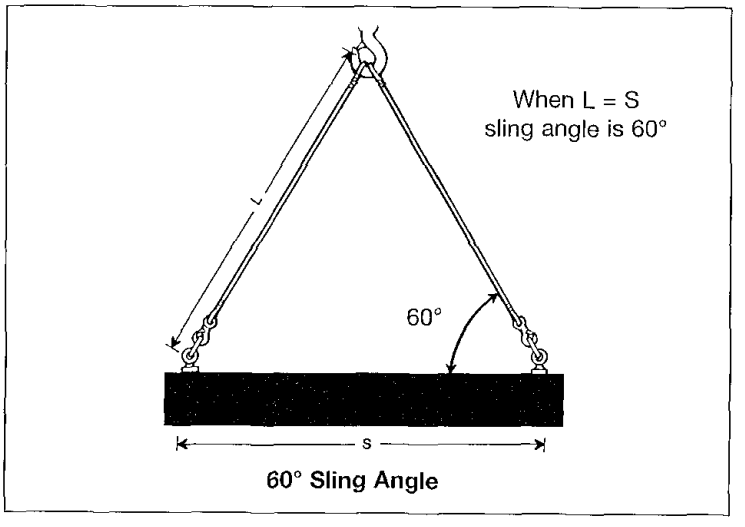


Figure 15

Remember — the smaller the sling angle, the lower the working load limit (WLL)

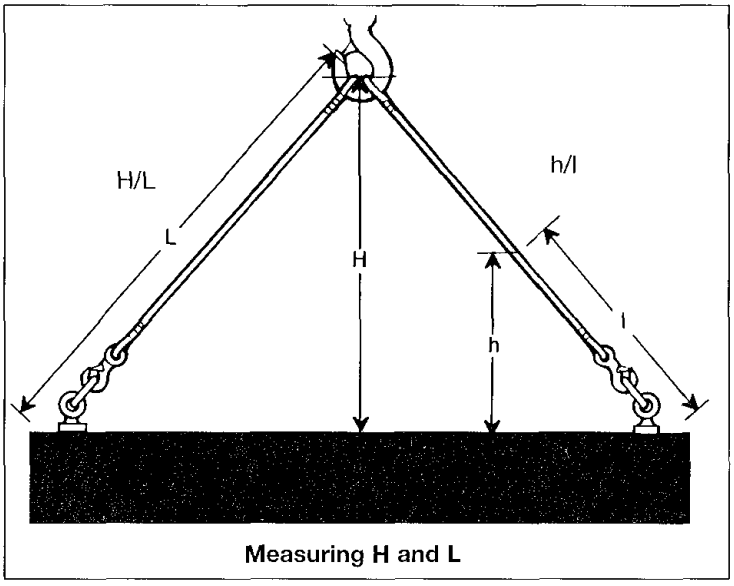
At a 45° sling angle, a sling will have a WLL equal to approximately 70% of the WLL of a single vertical hitch. At 60°, a sling will have a WLL of approximately 85% of the single vertical hitch.

Calculating WLL

Because it is difficult to remember all load, size, and sling angle combinations given in tables, use the following methods to estimate safe working loads for common sling configurations.

Each rule is based on the safe working load of a single vertical hitch of a given size and material and on the ratio H/L, where H is the vertical distance from the saddle of the hook to the top of the load and L is the distance, measured along the sling, from the saddle of the hook to the top of the load (Figure 16).

If you cannot measure the entire length of the sling, measure along the sling from the top of the load to a convenient point and call this distance "l". From this point measure down to the load and call this distance "h". The ratio h/l will be the same as the ratio H/L (Figure 16).



Measuring H and L

Figure 16

Either H/L or h/l will apply equally to the following methods. The efficiencies of end fittings must also be considered to determine the capacity of a sling assembly.

Bridle Hitches (2-Leg) (Figure 17)

$$WLL = WLL \text{ (of Single Vertical Hitch)} \times \frac{H}{L} \times 2$$

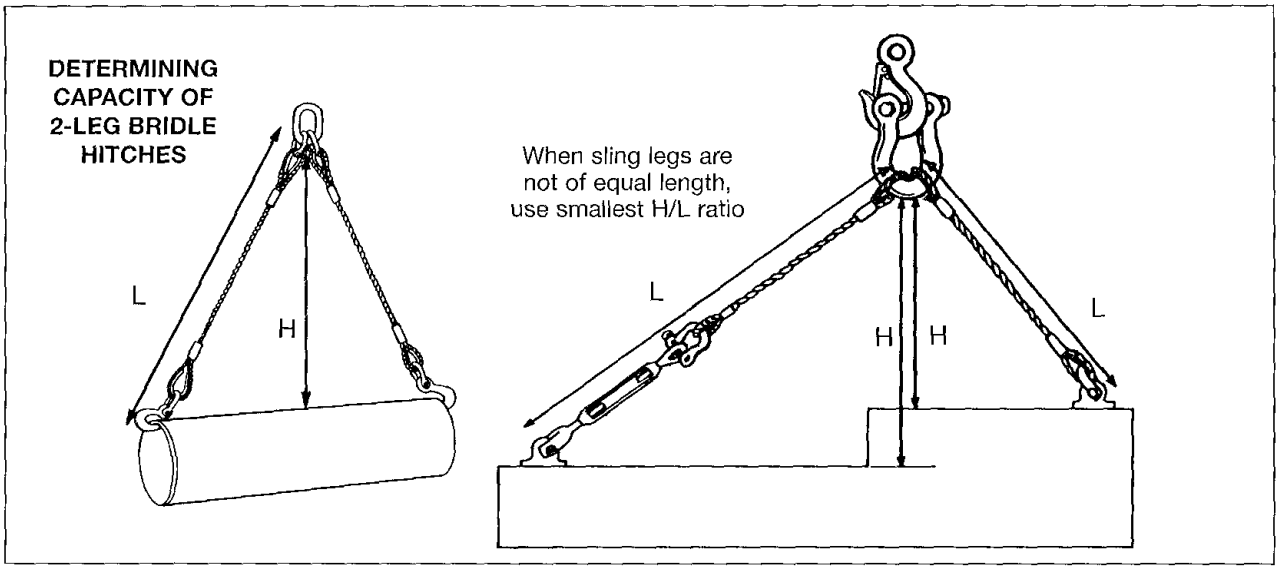


Figure 17

Bridle Hitches (more than 2 legs) (Figures 18 and 19)

Three- and four-leg hitches are rated equally to account for the possibility of unequal load distribution in a four-leg hitch.

$$WLL = WLL \text{ (of Single Vertical Hitch)} \times \frac{H}{L} \times 3$$

Three-leg hitches are less susceptible to unequal distribution since the load can tilt and equalize the loads in each leg. However, lifting an irregularly shaped, rigid load with a three-leg hitch may develop unequal loads in the sling legs. To be safe, use the formula for a two-leg bridle hitch under such circumstances.

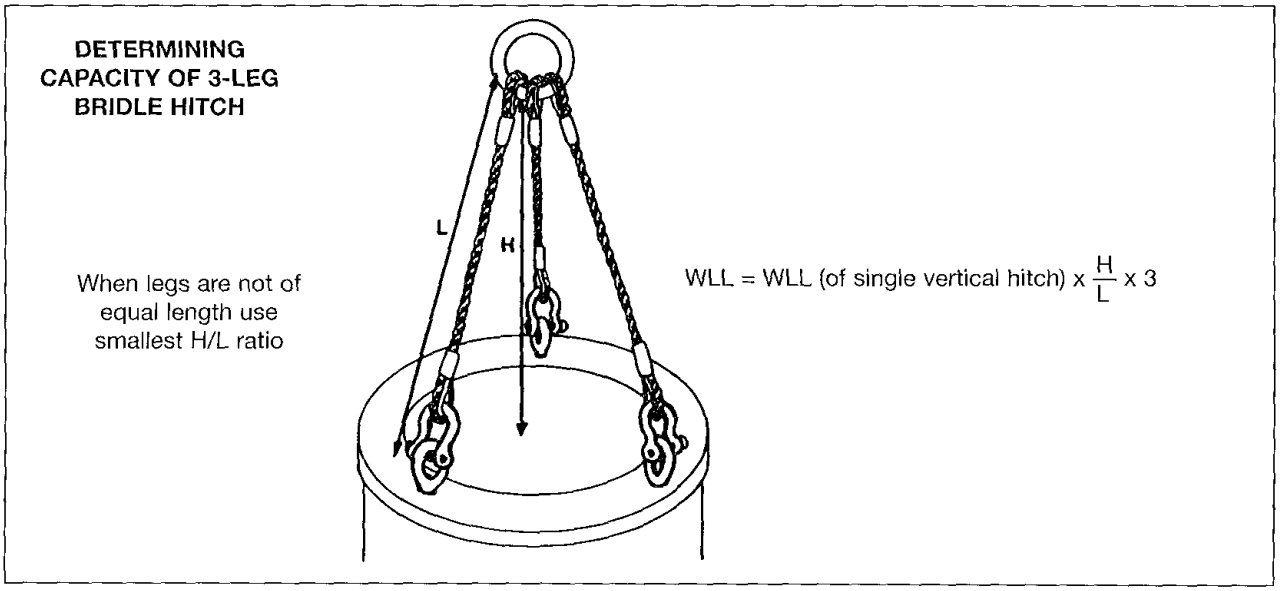


Figure 18

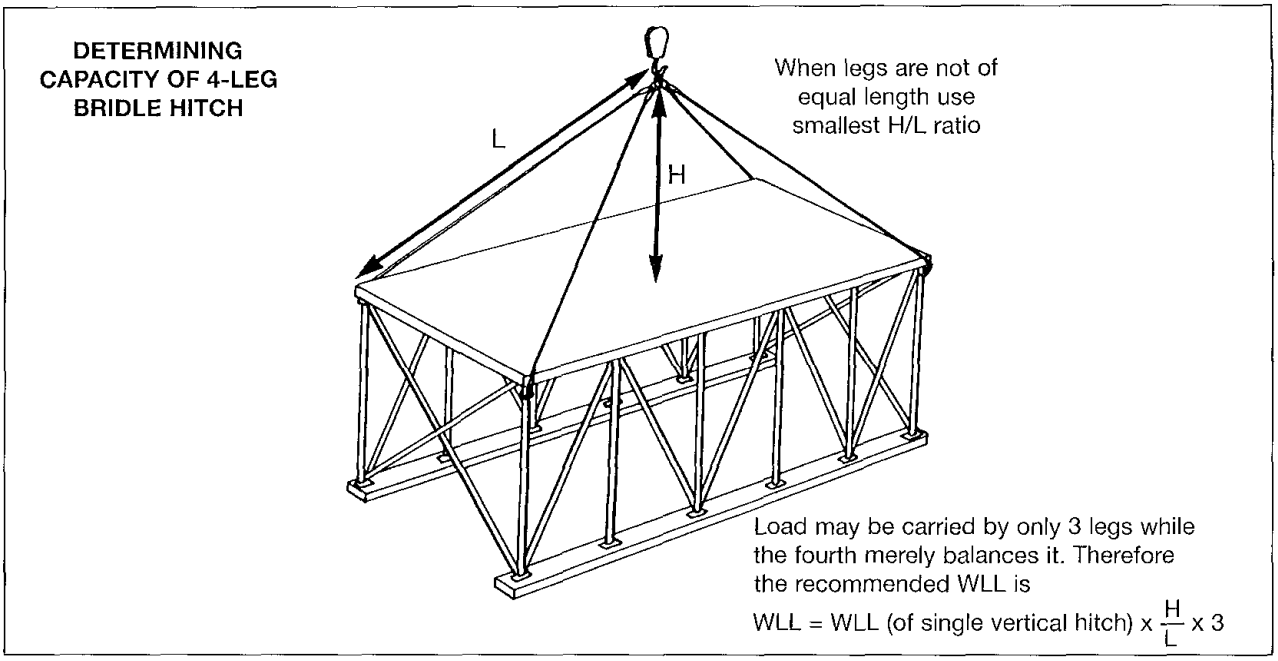


Figure 19

Remember that the rated capacity of a multi-leg sling is based on the assumption that all legs are used. If this is not the case, de-rate the sling assembly accordingly and hook all unused legs to the crane hook so they will not become snagged during the lift.

Single Basket Hitch (Figure 20)

For vertical legs - WLL = WLL (of Single Vertical Hitch) x 2

For inclined legs - WLL = WLL (of Single Vertical Hitch) x $\frac{H}{L}$ x 2

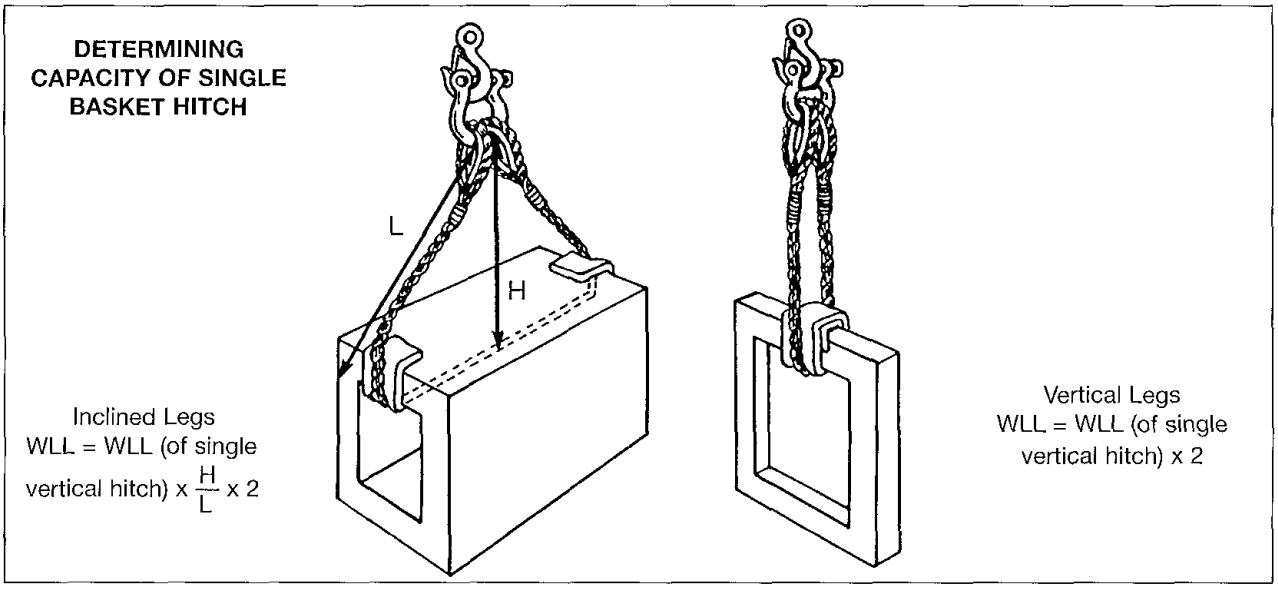


Figure 20

Double Basket Hitch (Figure 21)

For vertical legs - WLL = WLL (of Single Vertical Hitch) x 4

For inclined legs - WLL = WLL (of Single Vertical Hitch) x $\frac{H}{L}$ x 4

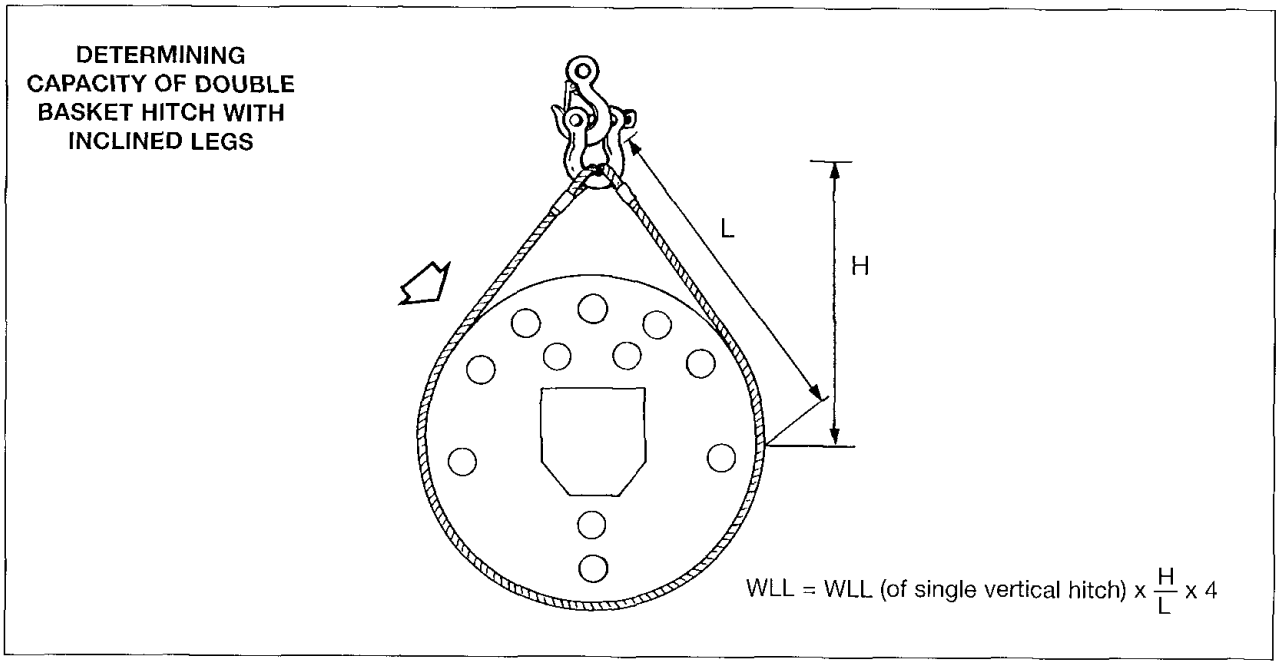


Figure 21

Double Wrap Basket Hitch

Depending on configuration, safe working loads are the same as for the Single Basket Hitch or the Double Basket Hitch.

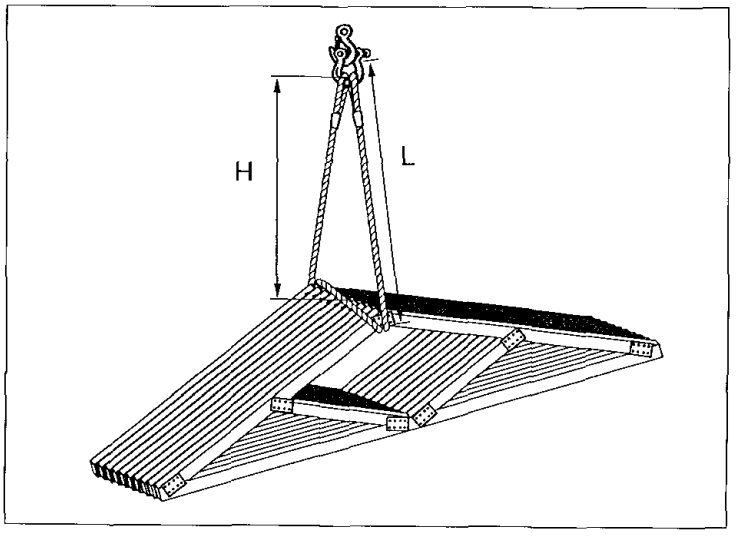


Figure 21a

Single Choker Hitch (Figure 22)

For sling angles of 45° or more —
WLL = WLL (of Single Vertical Hitch) x $\frac{3}{4}$

Sling angles of less than 45° are not recommended.
If they must be used the formula is:
WLL = WLL (of Single Vertical Hitch) x $\frac{A}{B}$

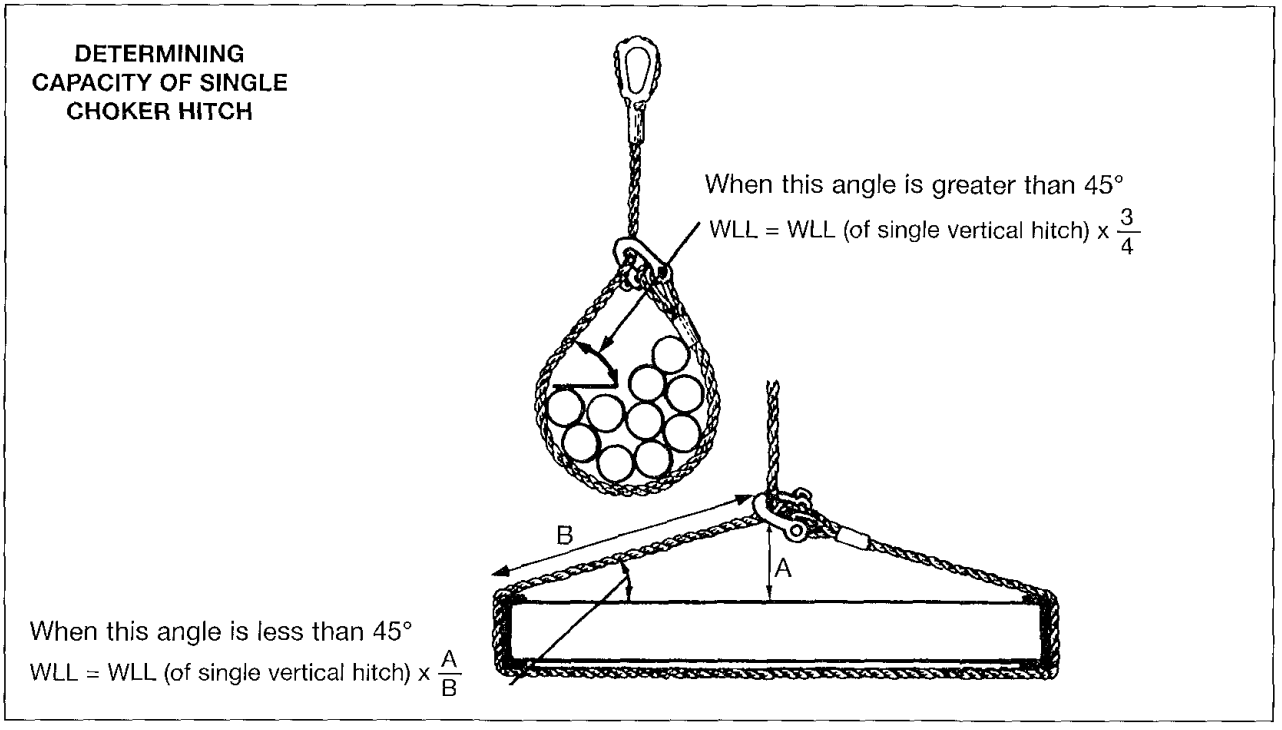


Figure 22

Endless and Grommet Slings

Although grommet slings support a load with two legs, their WLL is usually taken as 1.5 times the WLL of a single vertical hitch. This reduction allows for capacity lost because of sharp bends at the hook or shackle.

Double Choker Hitch (Figure 23)

For sling angles of 45° or more (formed by the choker) —

$$\text{WLL} = \text{WLL (of Single Vertical Hitch)} \times \frac{H}{L} \times \frac{3}{4} \times 2$$

Sling angles of less than 45° (formed by the choker) are not recommended.
If they must be used the formula is:

$$\text{WLL} = \text{WLL (of Single Vertical Hitch)} \times \frac{A}{B} \times \frac{H}{L} \times 2$$

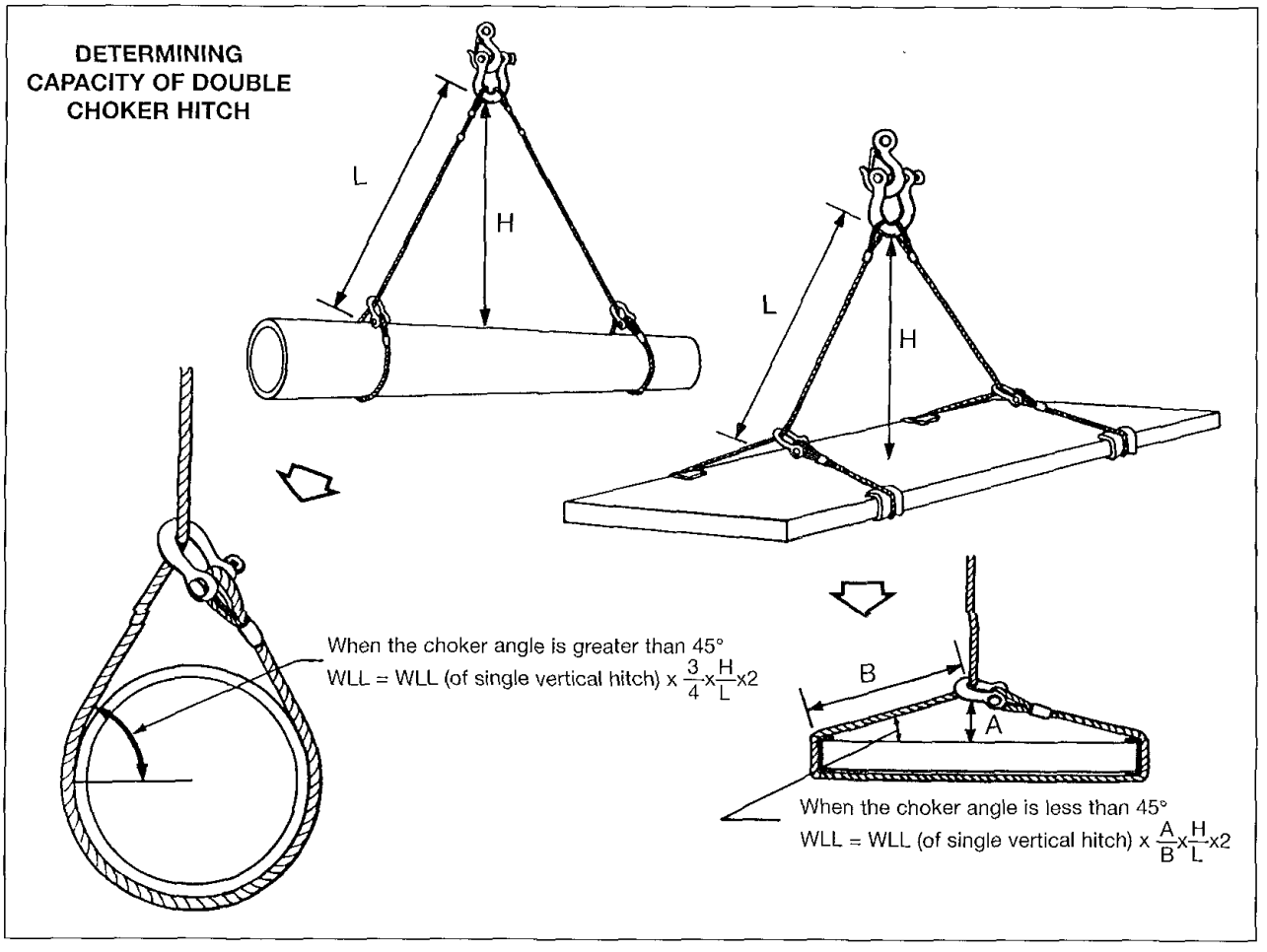


Figure 23

Double Wrap Choker Hitch

Depending on configuration, WLLs are the same as for the Single Choker Hitch or the Double Choker Hitch.

CENTRE OF GRAVITY

It is always important to rig the load so that it is stable. The load's centre of gravity must be directly under the main hook and below the lowest sling attachment point before the load is lifted (Figure 24).

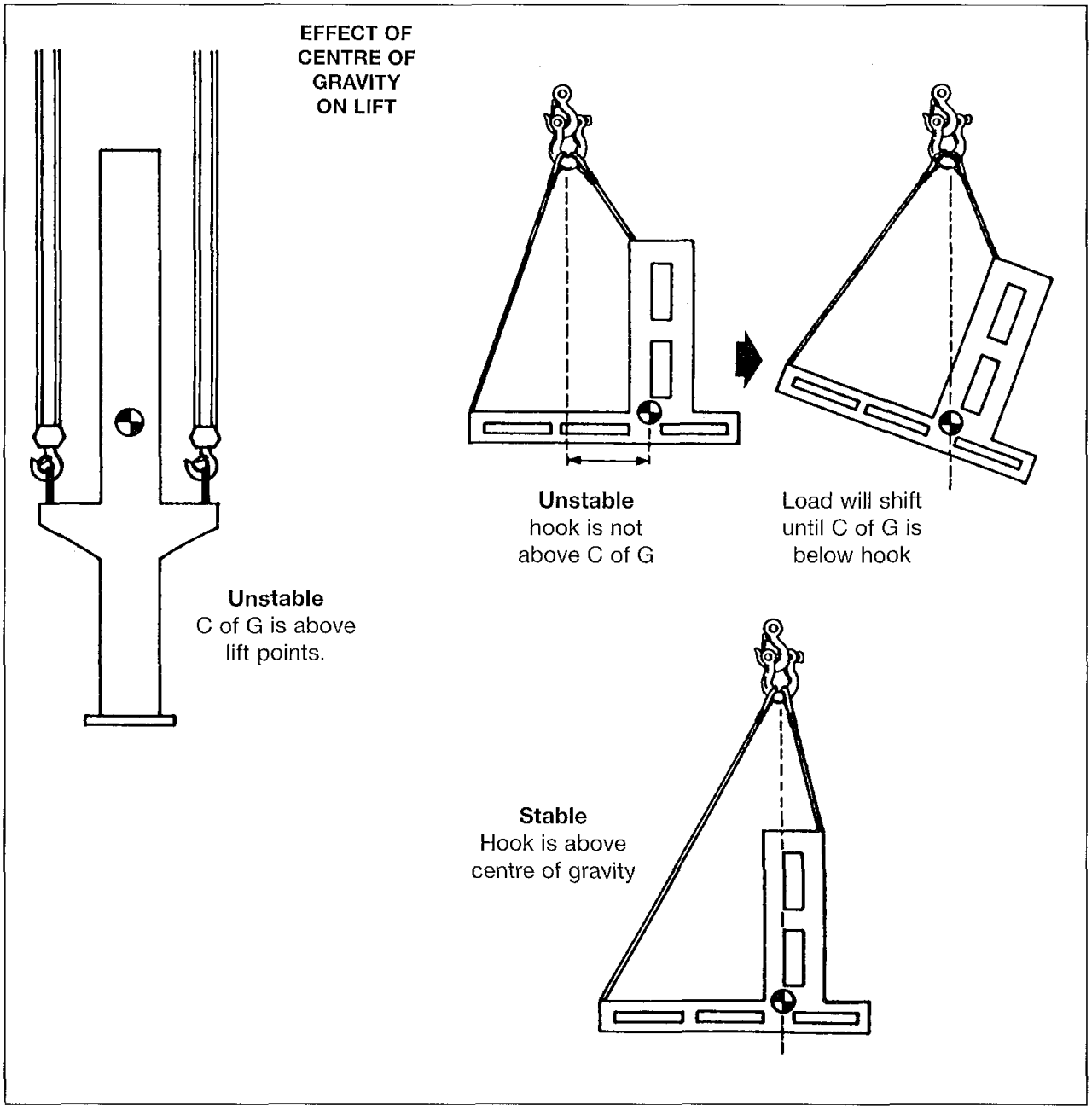


Figure 24

Centre of gravity is the point around which an object's weight is evenly balanced. The entire weight may be concentrated at this point. A suspended object will always move until its centre of gravity is directly below its suspension point. To make a level or stable lift, the crane or hook block must be directly above this point **before the load is lifted.** Thus a load which is slung above and through the centre of gravity will not topple or slide out of the slings (Figure 25).

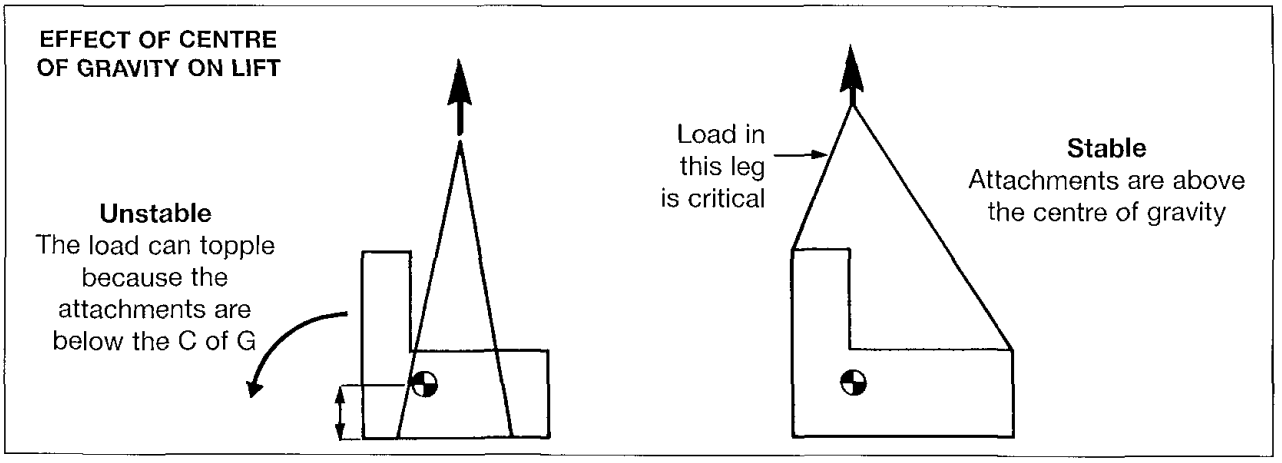


Figure 25

An object symmetrical in shape and uniform in composition will have its centre of gravity at its geometric centre. With odd-shaped objects, the centre of gravity can be more difficult to locate. Often the rigger must guess where it lies, rig accordingly, signal for a trial lift, and then, by watching the suspended load, determine the centre of gravity more exactly, adjusting hook, load, and sling suspension for the best balance and stability. The centre of gravity will lie somewhere along a line drawn vertically from the hook down through the load.

Remember that when the centre of gravity is closer to one sling attachment point than the other, the sling legs must be of unequal length, which means that their angles and loads will also be unequal.

When a lifted load tilts and rigging is not corrected, the tension will sharply increase on one sling leg and decrease on the other. If any load tilts more than 5° after it is lifted clear of the ground it should be landed and rigged over again.

It is equally important to ensure that the support points of a load (i.e. where the slings are attached to the load) lie above its centre of gravity. Under suspension, an object's centre of gravity will always seek the lowest level below the point of support. This knowledge is especially important for lifting pallets, skids, or the base of any object since they all have a tendency to topple. But this type of load will be inherently stable if the attachments are above the centre of gravity.

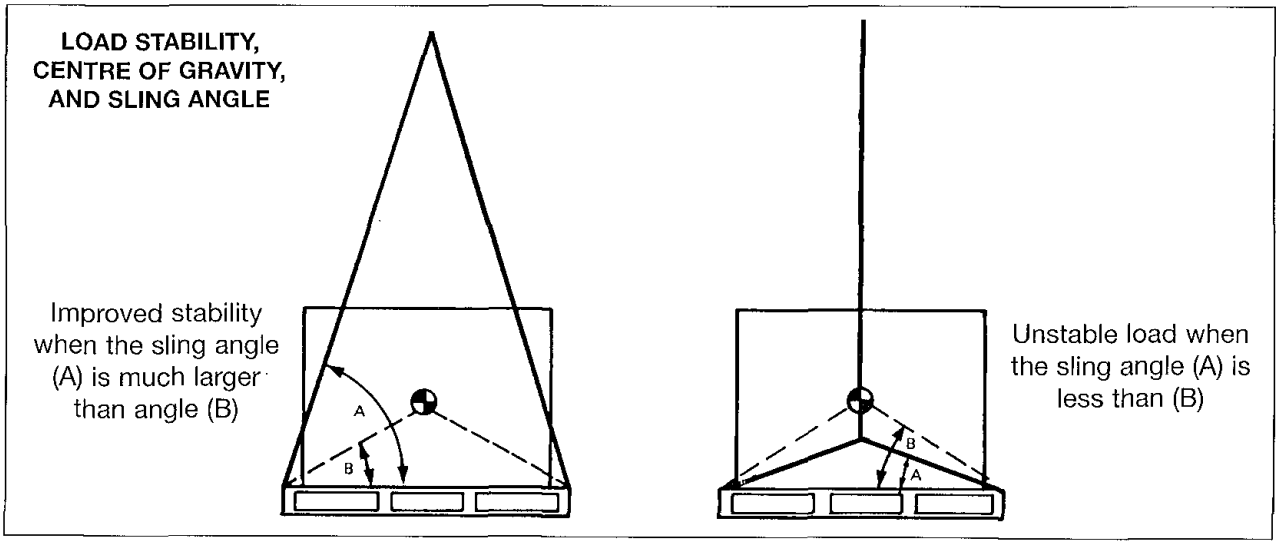


Figure 25a

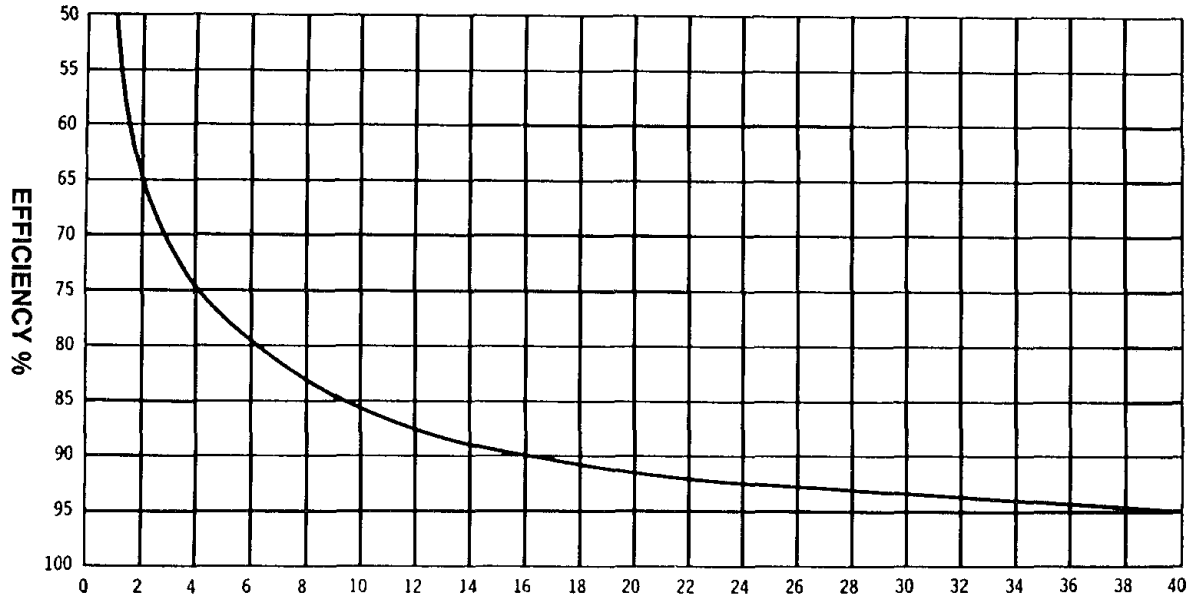
WIRE ROPE SLINGS

Wire rope slings should be inspected frequently for broken wires, kinks, abrasion, and corrosion. Inspection procedures and replacement criteria must be followed regardless of sling type or application.

All wire rope slings should be made of improved plow steel with independent wire rope cores to reduce the risk of crushing. Manufacturers will assist in selecting the rope construction for a given application.

It is recommended that all eyes in wire rope slings be equipped with thimbles, be formed with the Flemish Splice, and be secured by swaged or pressed mechanical sleeves or fittings. With the exception of socketed connections, this is the only method that produces an eye as strong as the rope itself, with reserve strength should the mechanical sleeve or fitting fail or loosen.

The capacity of a wire rope sling can be greatly affected by being bent sharply around pins, hooks, or parts of a load. The wire rope industry uses the term "D/d ratio" to express the severity of bend. "D" is the diameter of curvature that the rope or sling is subjected to and "d" is the diameter of the rope. Figure 26 shows the relationship between D/d ratio and efficiency. The minimum D/d ratio is usually taken as 20 which corresponds to 92% efficiency. While this may not seem acceptable at first glance, wire rope is usually at least 8% stronger than the catalogue strength. The bent sling at D/d = 20 can therefore be considered 100% efficient.



STRENGTH EFFICIENCY OF WIRE ROPE
WHEN BENT OVER PINS OR SHEAVES OF VARIOUS SIZES

Figure 26

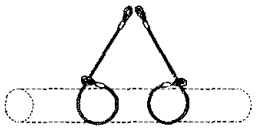
Tables 2-5 give typical working load limits for new wire rope slings made of improved plow steel. Manufacturers' ratings may vary.

Table 2

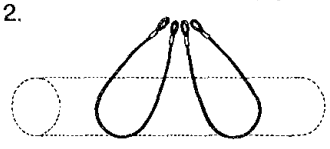
WIRE ROPE SLINGS
6 x 19 Classification Group, Improved Plow Steel, Fibre Core

Rope Diameter (Inches)	MAXIMUM WORKING LOAD LIMITS — POUNDS (Safety Factor = 5)					
	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined		
				60°	45°	30°
3/16	600	450	1,200	1,050	850	600
1/4	1,100	825	2,200	1,900	1,550	1,100
5/16	1,650	1,250	3,300	2,850	2,350	1,650
3/8	2,400	1,800	4,800	4,150	3,400	2,400
7/16	3,200	2,400	6,400	5,550	4,500	3,200
1/2	4,400	3,300	8,800	7,600	6,200	4,400
9/16	5,300	4,000	10,600	9,200	7,500	5,300
5/8	6,600	4,950	13,200	11,400	9,350	6,600
3/4	9,500	7,100	19,000	16,500	13,400	9,500
7/8	12,800	9,600	25,600	22,200	18,100	12,800
1	16,700	12,500	33,400	28,900	23,600	16,700
1 1/8	21,200	15,900	42,400	36,700	30,000	21,200
1 1/4	26,200	19,700	52,400	45,400	37,000	26,200
1 3/8	32,400	24,300	64,800	56,100	45,800	32,400
1 1/2	38,400	28,800	76,800	66,500	54,300	38,400
1 5/8	45,200	33,900	90,400	78,300	63,900	45,200
1 3/4	52,000	39,000	104,000	90,000	73,500	52,000
1 7/8	60,800	45,600	121,600	105,300	86,000	60,800
2	67,600	50,700	135,200	117,100	95,600	67,600
2 1/4	84,000	63,000	168,000	145,500	118,800	84,000
2 1/2	104,000	78,000	208,000	180,100	147,000	104,000
2 3/4	122,000	91,500	244,000	211,300	172,500	122,000

If used with Choker Hitch multiply above values by 3/4.



For Double Basket Hitch multiply above values by 2.



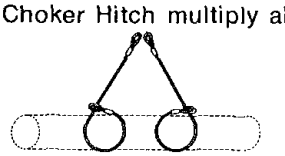
Note: Table values are for slings with eyes and thimbles in both ends, Flemish Spliced Eyes and mechanical sleeves.

Table 3

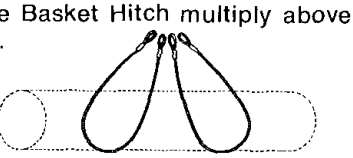
WIRE ROPE SLINGS
6 x 19 Classification Group, Improved Plow Steel, IWRC

Rope Diameter (Inches)	MAXIMUM WORKING LOAD LIMITS — POUNDS (Safety Factor = 5)					
	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined		
				60°	45°	30°
3/16	650	480	1,300	1,100	900	650
1/4	1,150	860	2,300	2,000	1,600	1,150
5/16	1,750	1,300	3,500	3,000	2,500	1,750
3/8	2,550	1,900	5,100	4,400	3,600	2,550
7/16	3,450	2,600	6,900	6,000	4,900	3,450
1/2	4,700	3,500	9,400	8,150	6,650	4,700
9/16	5,700	4,200	11,400	9,900	8,050	5,700
5/8	7,100	5,300	14,200	12,300	10,000	7,100
3/4	10,200	7,650	20,400	17,700	14,400	10,200
7/8	13,750	10,300	27,500	23,800	19,400	13,750
1	17,950	13,450	35,900	31,100	25,400	17,950
1 1/8	22,750	17,000	45,500	39,400	32,200	22,750
1 1/4	28,200	21,200	56,400	48,800	39,900	28,200
1 3/8	34,800	26,100	69,600	60,300	49,200	34,800
1 1/2	41,300	31,000	82,600	71,500	58,400	41,300
1 5/8	48,600	36,400	97,200	84,200	68,700	48,600
1 3/4	55,900	41,900	111,800	96,800	79,000	55,900
1 7/8	65,400	49,000	130,800	113,300	92,500	65,400
2	72,600	54,500	145,200	125,700	102,700	72,600
2 1/4	90,300	67,600	180,600	156,400	127,700	90,300
2 1/2	111,800	83,700	223,600	193,600	158,100	111,800
2 3/4	131,100	98,200	262,200	227,000	185,400	131,100

If used with Choker Hitch multiply above values by 3/4.



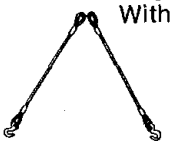
For Double Basket Hitch multiply above values by 2.



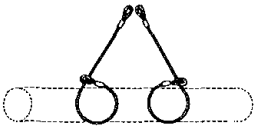
Note: Table values are for slings with eyes and thimbles in both ends, Flemish Spliced Eyes and mechanical sleeves.

Table 4

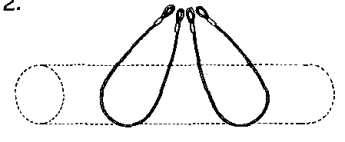
WIRE ROPE SLINGS
6 x 37 Classification Group, Improved Plow Steel, Fibre Core

Rope Diameter (Inches)	MAXIMUM WORKING LOAD LIMITS — POUNDS (Safety Factor = 5)					
	Single Vertical Hitch 	Single Choker Hitch 	Single Basket Hitch (Vertical Legs) 	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined  		
				60°	45°	30°
1/4	1,000	750	2,000	1,750	1,400	1,000
5/16	1,600	1,200	3,200	2,750	2,250	1,600
3/8	2,200	1,650	4,400	3,800	3,100	2,200
7/16	3,000	2,250	6,000	5,200	4,250	3,000
1/2	4,000	3,000	8,000	6,900	5,650	4,000
9/16	5,000	3,750	10,000	8,650	7,100	5,000
5/8	6,400	4,800	12,800	11,100	9,050	6,400
3/4	8,900	6,700	17,800	15,400	12,600	8,900
7/8	12,100	9,100	24,200	21,000	17,100	12,100
1	15,800	11,900	31,600	27,400	22,300	15,800
1 1/8	19,600	14,700	39,200	33,900	27,700	19,600
1 1/4	24,400	18,300	48,800	42,300	34,500	24,400
1 3/8	29,800	22,400	59,600	51,600	42,100	29,800
1 1/2	36,000	27,000	72,000	62,400	50,900	36,000
1 5/8	42,200	31,700	84,400	73,100	59,700	42,200
1 3/4	48,400	36,300	96,800	83,800	68,400	48,400
1 7/8	56,800	42,600	113,600	98,400	80,300	56,800
2	62,000	46,500	124,000	107,400	87,700	62,000
2 1/4	80,400	60,300	160,800	139,300	113,700	80,400
2 1/2	98,000	73,500	196,000	169,700	138,600	98,000
2 3/4	117,200	87,900	234,400	203,000	165,700	117,200

If used with Choker Hitch multiply above values by 3/4.



For Double Basket Hitch multiply above values by 2.



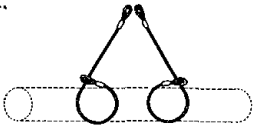
Note: **Table values are for slings with eyes and thimbles in both ends, Flemish Spliced Eyes and mechanical sleeves.**

Table 5

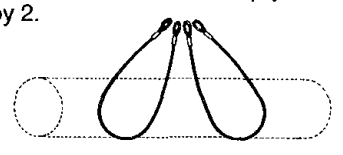
WIRE ROPE SLINGS
6 x 37 Classification Group, Improved Plow Steel, IWRC

Rope Diameter (Inches)	MAXIMUM WORKING LOAD LIMITS — POUNDS (Safety Factor = 5)					
	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined		
				60°	45°	30°
1/4	1,050	800	2,100	1,800	1,500	1,050
5/16	1,700	1,300	3,400	2,950	2,400	1,700
3/8	2,350	1,750	4,700	4,100	3,300	2,350
7/16	3,200	2,400	6,400	5,550	4,500	3,700
1/2	4,300	3,200	8,600	7,450	6,100	4,300
9/16	5,350	4,000	10,700	9,250	7,550	5,350
5/8	6,900	5,200	13,800	11,950	9,750	6,900
3/4	9,500	7,100	19,000	16,450	13,400	9,500
7/8	13,000	9,750	26,000	22,500	18,400	13,000
1	17,000	12,750	34,000	29,450	24,000	17,000
1 1/8	21,000	15,750	42,000	36,400	29,700	21,000
1 1/4	26,200	19,650	52,400	45,400	37,000	26,200
1 3/8	32,000	24,000	64,000	55,400	45,200	32,000
1 1/2	39,500	29,600	79,000	68,400	55,900	39,500
1 5/8	45,400	34,000	90,800	78,600	64,200	45,400
1 3/4	52,000	39,000	104,000	90,000	73,500	52,000
1 7/8	61,000	45,750	122,000	105,700	86,300	61,000
2	66,600	49,950	133,200	115,400	94,200	66,600
2 1/4	86,400	64,800	172,800	149,600	122,200	86,400
2 1/2	105,300	79,000	210,600	182,400	148,900	105,300
2 3/4	126,000	94,500	252,000	218,200	178,200	126,000

If used with Choker Hitch multiply above values by 3/4.



For Double Basket Hitch multiply above values by 2.



Note: Table values are for slings with eyes and thimbles in both ends, Flemish Spliced Eyes and mechanical sleeves.

CHAIN SLINGS

Chain slings are suited to applications requiring flexibility and resistance to abrasion, cutting, and high temperatures.

Alloy steel chain grade 80 is marked with an 8, 80, or 800; grade 100 is marked with a 10, 100, or 1000. The letter T is referred to in the American Society for Testing and Materials (ASTM) standard as one acceptable marking for alloy chain. However, not all manufacturers fabricate to this standard.

As with all slings and associated hardware, chain slings must have a factor of safety of 5. In North America, chain manufacturers usually give working load limits based on a factor of safety of 3.5 or 4. Always check with manufacturers to determine the factor of safety on which their WLLs are based.

If the factor of safety is less than 5, calculate the WLL of the chain by multiplying the catalogue WLL by the manufacturer's factor of safety and dividing by 5.

$$\frac{\text{Catalogue WLL} \times \text{Manufacturer's F.S.}}{5} = \text{WLL (based on factor of safety of 5)}$$

Example — 1/2" Alloy Steel Chain

$$\frac{\text{Catalogue WLL} \times \text{Factor of Safety}}{5} = \frac{13{,}000 \text{ lbs.} \times 3.5}{5} = 9{,}100 \text{ lbs.}$$

This chain sling must be de-rated to 9,100 lbs. for construction applications.

Wherever they bear on sharp edges, chain slings should be padded to prevent links from being bent and to protect the load. Chain sling capacity is affected by D/d ratio. Never tie a knot in a chain sling to shorten the reach. Slings can be supplied with grab hooks or shortening clutches for such applications.

Inspect chain slings for inner link wear and wear on the outside of the link barrels (Figure 27). Manufacturers publish tables of allowable wear for various link sizes. Many companies will also supply wear gauges to indicate when a sling must be retired or links replaced. Gauges or tables from a particular manufacturer should only be used on that brand of chain since exact dimensions of a given nominal size can vary from one manufacturer to another.

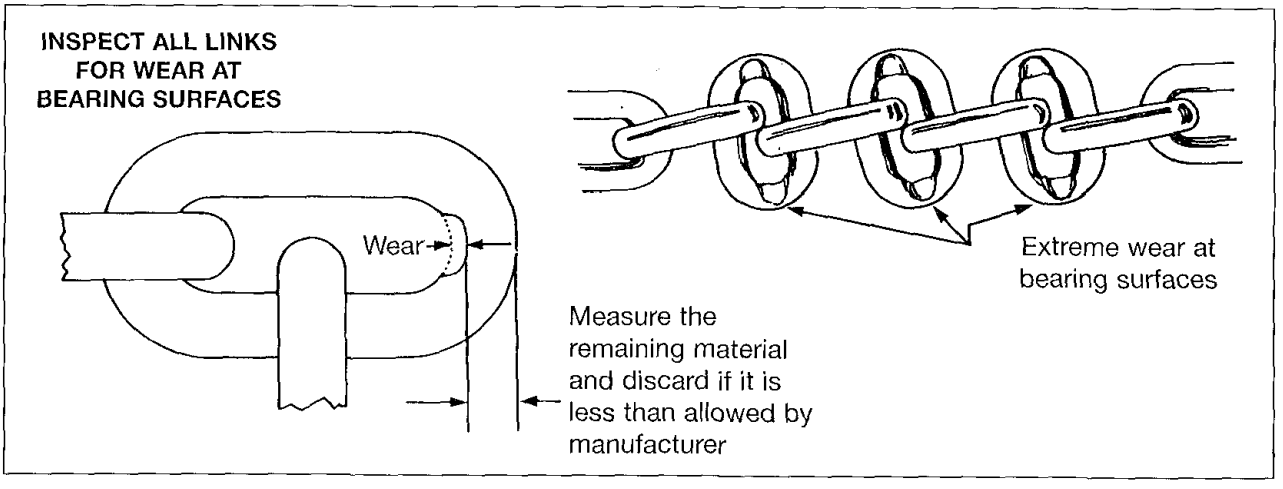


Figure 27

Chain slings should be inspected for nicks and gouges which cause stress concentrations and weaken the link (Figure 28). Nicks and gouges should be ground out and the new diameter checked with gauges or tables.

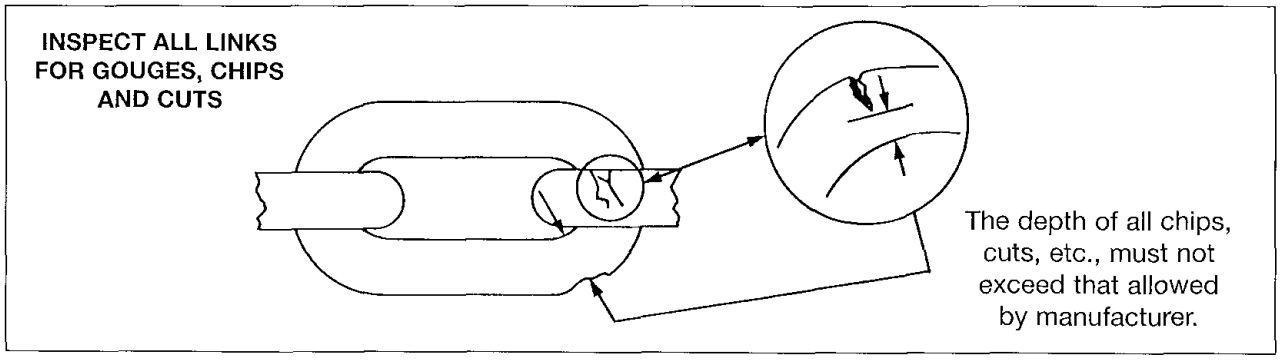


Figure 28

Never use repair links or mechanical coupling links to splice broken lengths of alloy steel chain. They are much weaker than the chain links. Never use a chain if the links are stretched or do not move freely.

Table 6 gives working load limits for grade 8 ("T") alloy steel chain.

TABLE 6

CHAIN SLINGS (ALLOY STEEL)						
Chain Size (Inches)	MAXIMUM WORKING LOAD LIMITS — POUNDS					
	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined		
				60°	45°	30°
1/4	3,250	2,440	6,500	5,600	4,600	3,250
3/8	6,600	4,950	13,200	11,400	9,300	6,600
1/2	11,250	8,400	22,500	19,500	15,900	11,250
5/8	16,500	12,400	33,000	28,600	23,300	16,500
3/4	23,000	17,200	46,000	39,800	32,500	23,000
7/8	28,750	21,500	57,500	49,800	40,600	28,750
1	38,750	29,000	77,500	67,100	54,800	38,750
1 1/8	44,500	33,400	89,000	77,000	63,000	44,500
1 1/4	57,500	43,000	115,000	99,500	81,000	57,500
1 3/8	67,000	50,000	134,000	116,000	94,500	67,000
1 1/2	80,000	60,000	160,000	138,000	113,000	80,000
1 3/4	100,000	75,000	200,000	173,000	141,000	100,000
				If used with Choker Hitch multiply above values by 3/4.		
				For Double Basket Hitch multiply above values by 2.		

SYNTHETIC WEB SLINGS

Web slings are available in two materials — nylon and polyester (Dacron). Nylon is resistant to many alkalis whereas polyester is resistant to many acids. Consult the manufacturer before using web slings in a chemical environment. Nylon slings are more common but polyester slings are often recommended where headroom is limited since they stretch only half as much as nylon slings.

Synthetic web slings offer a number of advantages for rigging purposes.

- Their relative softness and width create much less tendency to mar or scratch finely machined, highly polished, or painted surfaces and less tendency to crush fragile objects than fibre rope, wire rope, or chain slings (Figure 29).

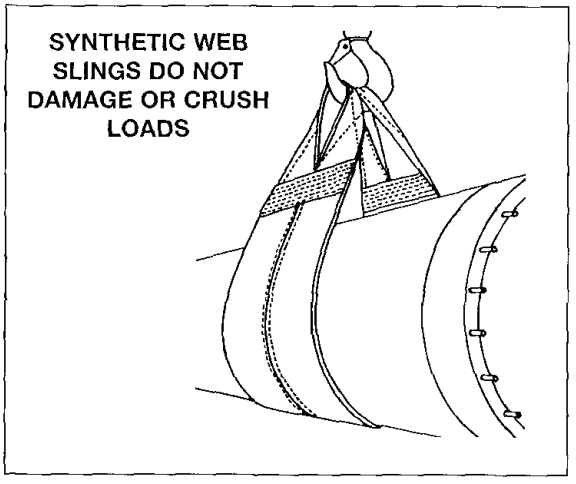


Figure 29

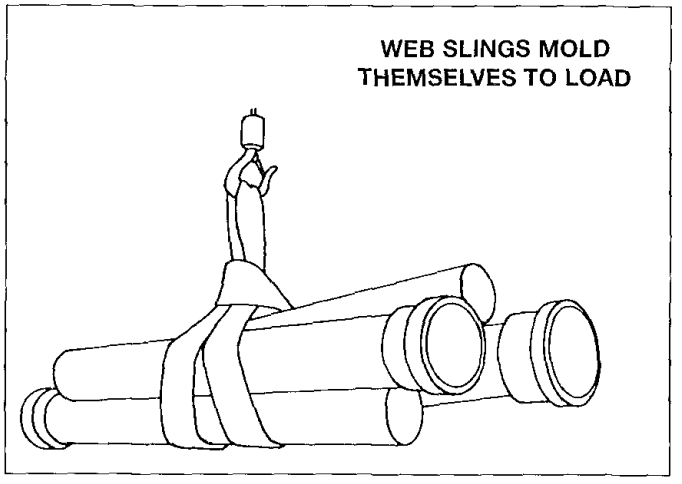


Figure 30

- Because of their flexibility, synthetic web slings tend to mold themselves to the shape of the load (Figure 30).
- Synthetic web slings are not affected by certain chemicals.
- They do not rust and thus will not stain ornamental precast concrete or stone.
- They are non-sparking and can be used safely in explosive atmospheres.
- They minimize twisting and spinning during lifting.
- Their light weight permits ease of rigging, their softness precludes hand cuts, and the danger of harm from a free-swinging sling is minimal.
- They are elastic and stretch under load more than either wire rope or chain and can thus absorb heavy shocks and cushion loads. In cases where sling stretching must be minimized, a sling of larger load capacity or a polyester sling should be used.

Synthetic web slings are available in a number of configurations useful in construction.

Endless or Grommet Slings — both ends of one piece of webbing lapped and sewn to form a continuous piece. They can be used as vertical hitches, bridle hitches, in choker arrangements, or as basket hitches. Because load contact points can be shifted with every lift, wear is evenly distributed and sling life extended (Figure 31).

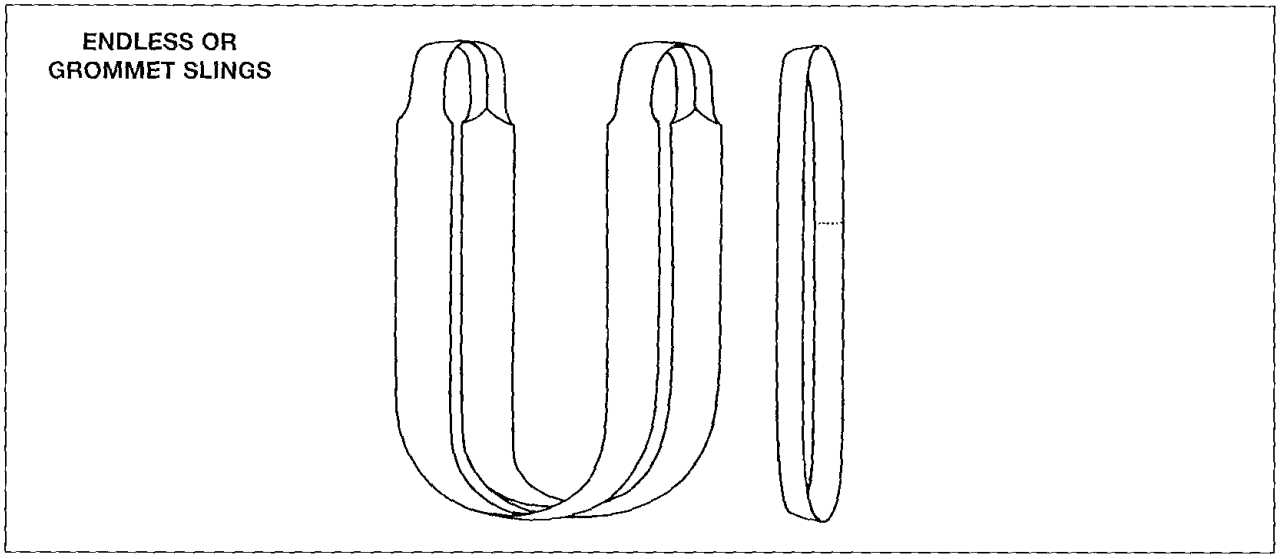


Figure 31

Standard Eye-and-Eye — webbing assembled and sewn to form a flat body sling with an eye at each end and eye openings in the same plane as the sling body. The eyes may be either full web width or tapered by being folded and sewn narrower than the webbing width (Figure 32).

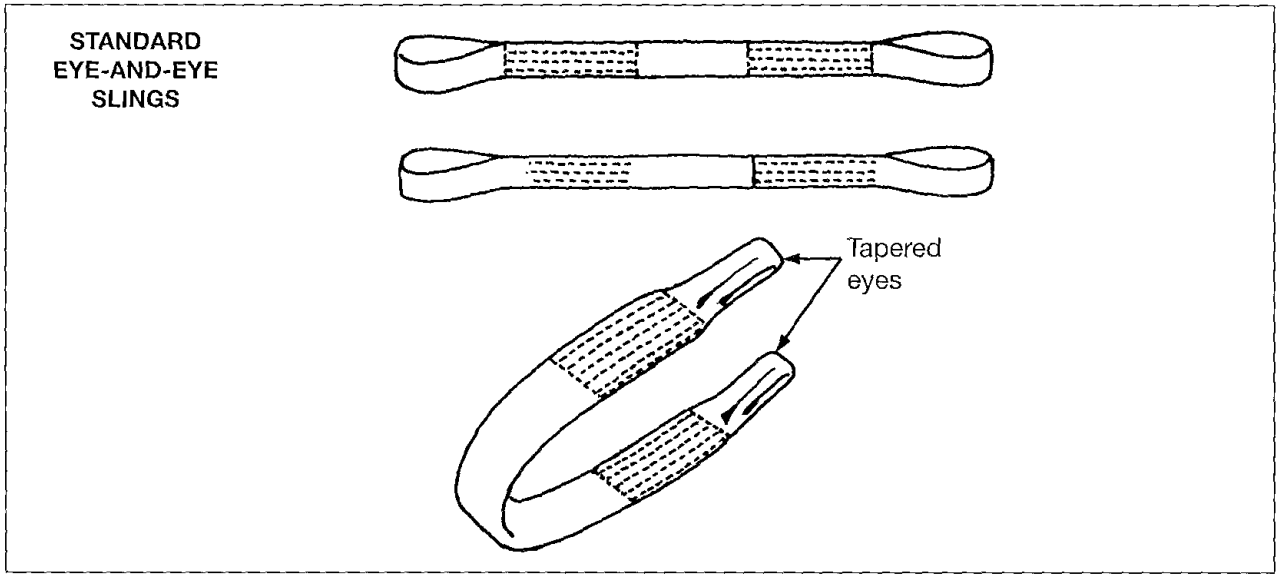


Figure 32

Twisted Eye — en eye-and-eye with twisted terminations at both ends. The eye openings are at 90° to the plane of the sling body. This configuration is available with either full-width or tapered eyes (Figure 33).

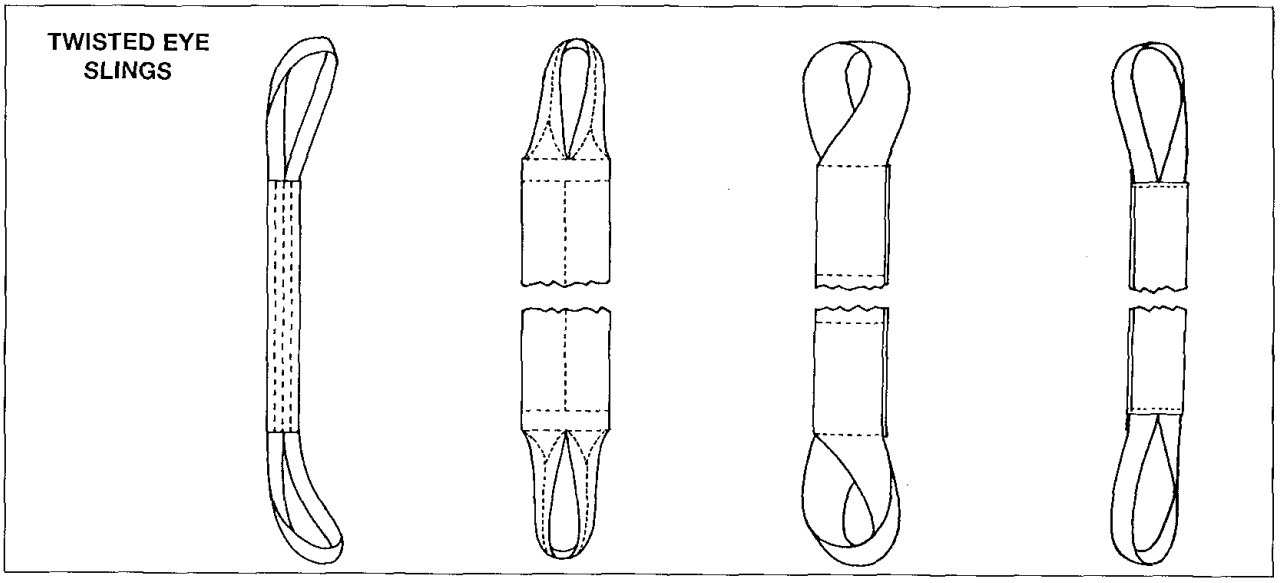


Figure 33

In place of sewn eyes, web slings are available with metal end fittings. The most common are triangle and choker hardware. Combination hardware consists of a triangle for one end of the sling and a triangle/rectangle (choker attachment) for the other end. With this arrangement, choker and basket as well as straight hitches may be rigged. Such attachments help reduce wear in the sling eyes and thus lengthen sling life (Figure 34).

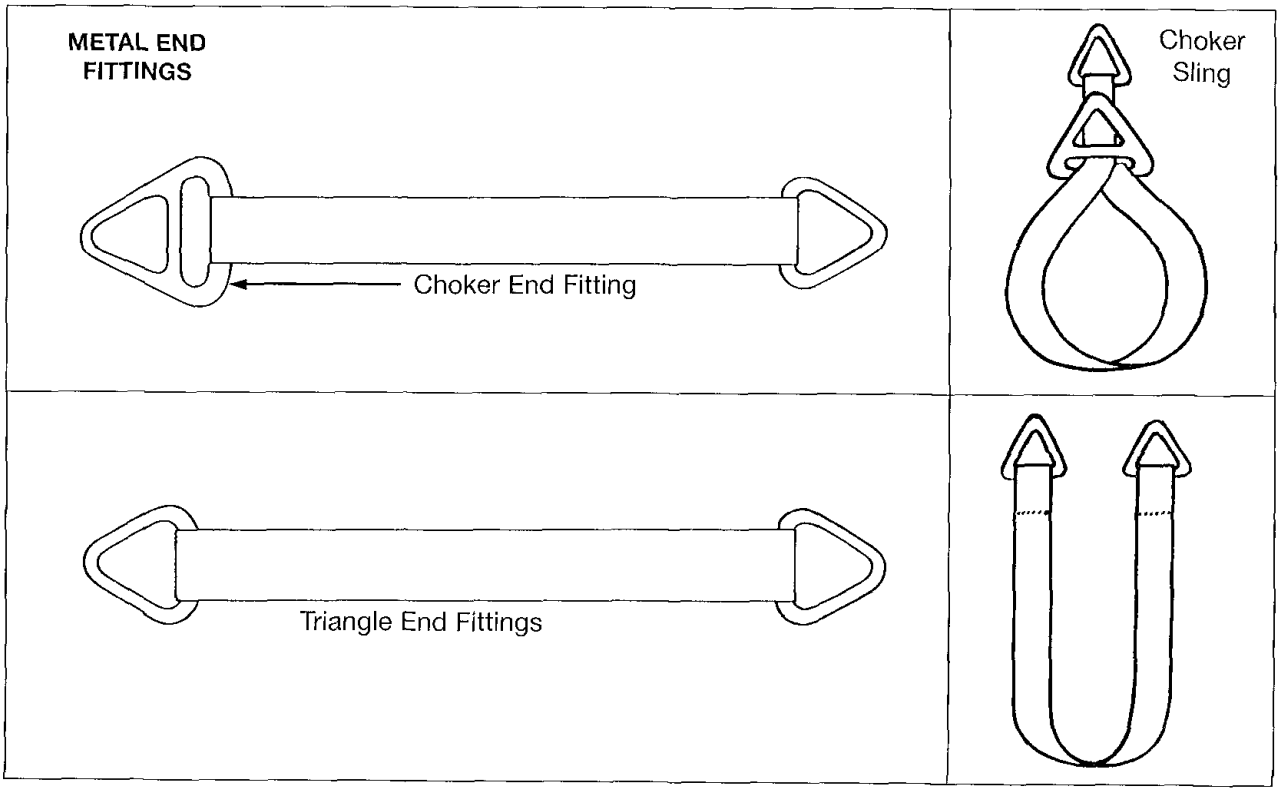


Figure 34

Despite their inherent toughness, synthetic web slings can be cut by repeated use around sharp-cornered objects and abraded by continually hoisting rough-surfaced loads.

Protective devices offered by most sling manufacturers can minimize these effects.

- **Buffer strips** of leather, nylon, or other materials sewn on the body of the sling protect against wear (Figure 35A). Leather pads are most resistant to wear and cutting, but are subject to weathering and deterioration. They are not recommended in lengths over six feet because their stretch characteristics differ from those of webbing. On the other hand, nylon web wear pads are more resistant to weathering, oils, grease, and most alkalis. Moreover they stretch in the same ratio as the sling body.
- **Edge guards** consist of strips of webbing or leather sewn around each edge of the sling (Figure 35B). This is necessary whenever sling edges are subject to damage.
- **Sleeve or sliding tube wear pads** are available for slings used to handle material with sharp edges. The pads are positioned on the sling where required, will not move when the sling stretches, adjust to the load, and cover both sides of the sling (Figure 35C).

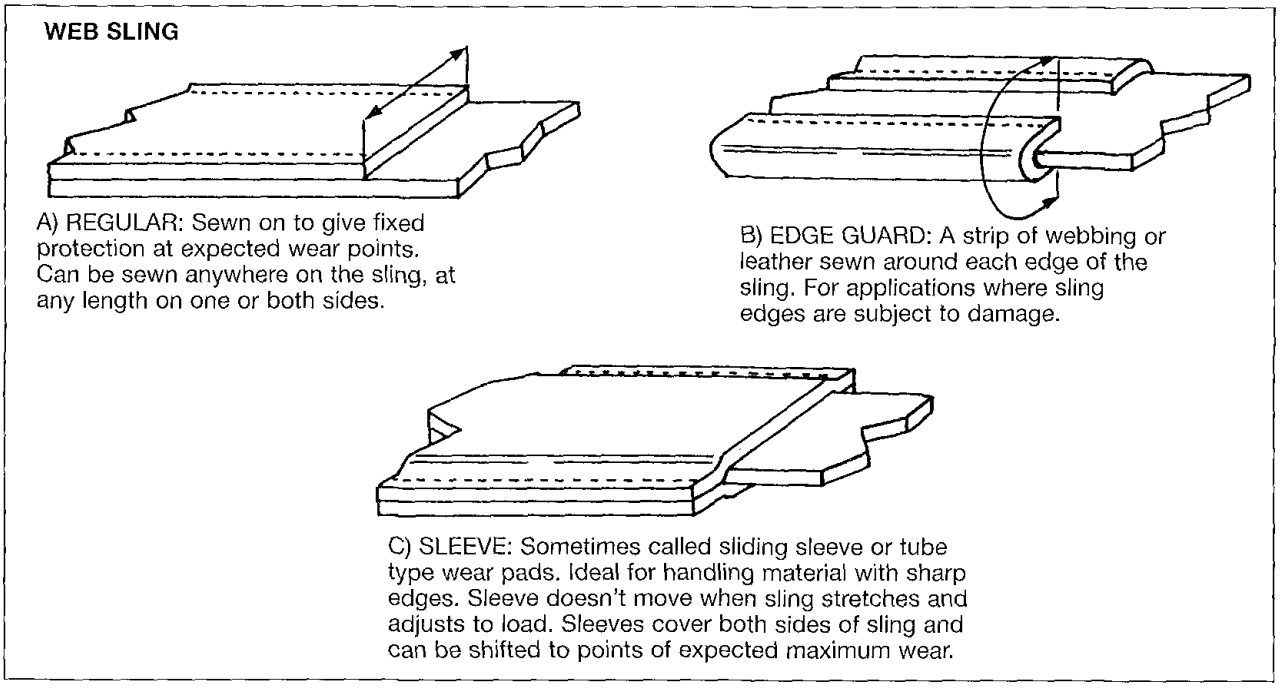


Figure 35

- **Reinforcing strips** sewn into the sling eyes double or triple the eye thickness and greatly increase sling life and safety.
- **Coatings** provide added resistance to abrasion and chemicals as well as a better grip on slippery loads. Coatings can be brightly coloured for safety or load rating.
- **Cotton-faced nylon webbing** affords protection for hoisting granite and other rough-surfaced material.

The rated capacity of synthetic web slings is based on the tensile strength of the webbing, a factor of safety of 5, and the fabrication efficiency. Fabrication efficiency accounts for loss of strength in the webbing after it is stitched and otherwise modified during manufacture. Fabrication efficiency is typically 80% to 85% for single-ply slings but will be lower for multi-ply slings and very wide slings.

Although manufacturers provide tables for bridle and basket configurations, these should be used with extreme caution. At low sling angles one edge of the web will be overloaded and the sling will tend to tear (Figure 36).

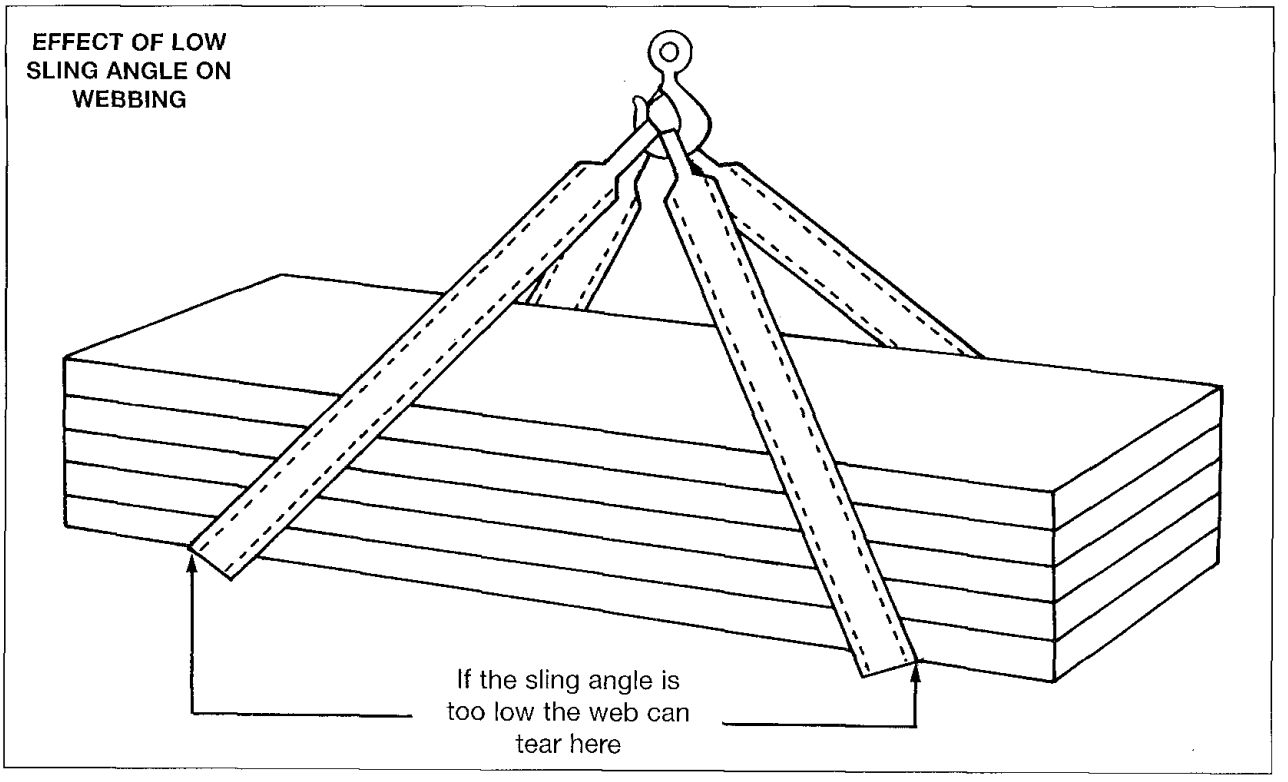


Figure 36

Slings with aluminum fittings should never be used in acid or alkali environments. Nylon and polyester slings must not be used at temperatures above 90°C (194°F).

Inspect synthetic web slings regularly. Damage is usually easy to detect. Cuts, holes, tears, frays, broken stitching, worn eyes and worn or distorted fittings, and burns from acid, caustics or heat are immediately evident and signal the need for replacement. Never attempt repairs yourself.

ROUND SLINGS

Round slings can be used in the same way as an endless sling. They offer additional advantages in that their jackets shield the fibre against ultraviolet degradation. A round sling is also easy to inspect and evaluate — if its jacket is damaged, take the sling out of service. Round slings have larger capacities than their web cousins of the same width. They can therefore be narrower. This means that round slings can be slung on hooks without bunching.

METAL MESH SLINGS

Metal mesh slings, also known as wire or chain mesh slings, are well adapted for use where loads are abrasive, hot, or tend to cut fabric slings and wire ropes. Metal mesh slings resist abrasion and cutting, grip the load firmly without stretching, and can withstand temperatures up to 288°C (550°F). They have smooth, flat bearing surfaces, conform to irregular shapes, do not kink or tangle, and resist corrosion (Figure 37).

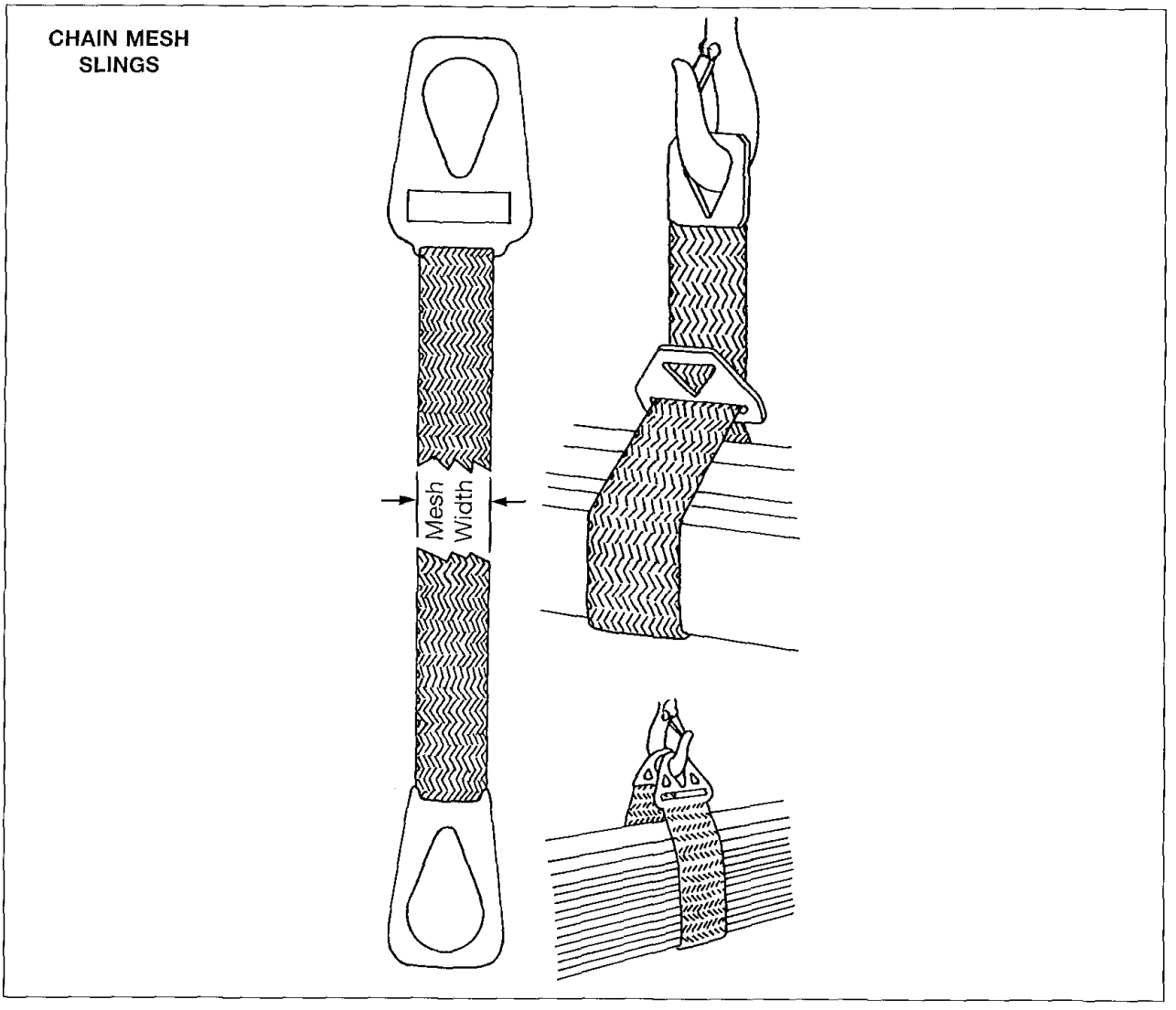
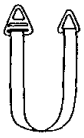
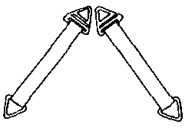
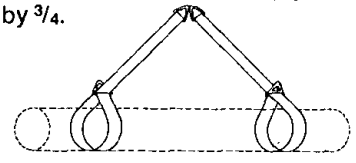
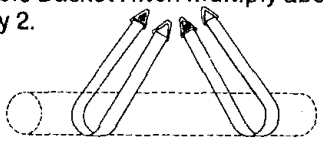


Figure 37

For handling loads that would damage the mesh, or for handling loads that the mesh would damage, the slings can be coated with rubber or plastic. See Table 7 for working load limits.

Note that there is no reduction in WLL for the choker hitch. This is because the hinge action of the mesh prevents any bending of individual wire spirals.

Table 7

METAL (WIRE OR CHAIN) MESH SLINGS						
Sling Width (Inches)	MAXIMUM WORKING LOAD LIMITS — POUNDS (Safety Factor = 5)					
	Single Vertical Hitch 	Single Choker Hitch 	Single Basket Hitch (Vertical Legs) 	2-Leg Bridle Hitch & Single Basket Hitch Non Vertical Legs  		
				60°	45°	30°
HEAVY DUTY CLASSIFICATION (10 GAUGE MESH)						
2	1,500	1,100	3,000	2,600	2,100	1,500
3	2,700	2,000	5,400	4,700	3,800	2,700
4	4,000	3,000	8,000	6,900	5,600	4,000
6	6,000	4,500	12,000	10,400	8,500	6,000
8	8,000	6,000	16,000	13,800	11,300	8,000
10	10,000	7,500	20,000	17,300	14,100	10,000
12	12,000	9,000	24,000	20,800	17,000	12,000
MEDIUM DUTY CLASSIFICATION (12 GAUGE MESH)						
2	1,350	1,000	2,700	2,300	1,900	1,350
3	2,000	1,500	4,000	3,500	2,800	2,000
4	2,700	2,000	5,400	4,700	3,800	2,700
6	4,500	3,400	9,000	7,800	6,400	4,500
8	6,000	4,500	12,000	10,400	8,500	6,000
10	7,500	5,600	15,000	13,000	10,600	7,500
12	9,000	6,750	18,000	15,600	12,700	9,000
LIGHT DUTY CLASSIFICATION (14 GAUGE MESH)						
2	900	700	1,800	1,600	1,300	900
3	1,400	1,000	2,800	2,400	2,000	1,400
4	2,000	1,500	4,000	3,500	2,800	2,000
6	3,000	2,250	6,000	5,200	4,200	3,000
8	4,000	3,000	8,000	6,900	5,700	4,000
10	5,000	3,750	10,000	8,600	7,100	5,000
12	6,000	4,500	12,000	10,400	8,500	6,000
				If used with Choker Hitch multiply above values by 3/4. 		
				For Double Basket Hitch multiply above values by 2. 		

FIBRE ROPE SLINGS

Fibre rope slings are preferred for some applications because they are pliant, grip the load well, and do not mar its surface. They should be used only on light loads, however, and must never be used on objects that have sharp edges capable of cutting the rope or in applications where the sling will be exposed to high temperatures, severe abrasion, or acids.

Check manufacturer's specifications. Criteria for removing fibre rope slings from service vary from one manufacturer to another. Fibre rope lifting capacity is also greatly affected by the D/d ratio.

The choice of rope type and size will depend on the application, the weight to be lifted, and the sling angle. Before lifting any load with a fibre rope sling, be sure to inspect the sling carefully. Fibre slings, especially manila, deteriorate far more rapidly than wire rope slings and their actual strength is very difficult to estimate.