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Crane & Rigging Regulations & Standards

OSHA

1917.45 – Cargo Handling Gear and Equipment

1926.550 - Cranes and Derricks in the Construction Industry

ANSI

B30.26 - Rigging Hardware

B30.9 - Slings

OSHA 1917.45

Cargo Handling Gear and Equipment

Cranes and derricks (See also 1917.50). - 1917.45

Regulations (Standards - 29 CFR) - Table of Contents

- **Part Number:** 1917
- **Part Title:** Marine Terminals
- **Subpart:** C
- **Subpart Title:** Cargo Handling Gear and Equipment
- **Standard Number:** 1917.45
- **Title:** Cranes and derricks (See also 1917.50).

1917.45(a)

Coverage.

1917.45(a)(1)

This section applies to every kind of crane and derrick and to any other type of equipment performing the functions of a crane or derrick except as noted in paragraph (a)(2) of this section.

1917.45(a)(2)

This section does not apply to small industrial truck-type cranes, container handling top-loaders and sideloaders, chain hoists, and mobile straddle-type cranes incapable of straddling two or more intermodal containers (16 feet (4.88 m) in width).

1917.45(b)

Ratings.

1917.45(b)(1)

Except for bridge cranes covered by paragraph (g) of this section, cranes and derricks having ratings that vary with boom length, radius (outreach) or other variables shall have a durable rating chart visible to the operator, covering the complete range of the manufacturer's (or design) capacity ratings. The rating chart shall include all operating radii (outreach) for all permissible boom lengths and jib lengths as applicable, with and without outriggers, and alternate ratings for optional equipment affecting such ratings. Precautions or warnings specified by the owner or manufacturer shall be included along with the chart.

..1917.45(b)(2)

1917.45(b)(2)

The manufacturer's (or design) rated loads for the conditions of use shall not be exceeded.

1917.45(b)(3)

Designated working loads shall not be increased beyond the manufacturer's ratings or original design limitations unless such increase receives the manufacturer's approval. When the manufacturer's services are not available or where the equipment is of foreign manufacture, engineering design analysis shall be performed or approved by a person accredited for certificating the equipment under Part 1919 of this chapter. Engineering design analysis shall be performed by a registered professional engineer competent in the field of cranes and derricks. Any structural changes necessitated by the change in rating shall be carried out.

1917.45(c)

Radius indicator. When the rated load varies with the boom radius, the crane or derrick shall be fitted with a boom angle or radius indicator visible to the operator.

1917.45(d)

Prohibited usage.

1917.45(d)(1)

Equipment shall not be used in a manner that exerts side loading stresses upon the crane or derrick boom.

1917.45(d)(2)

No crane or derrick having a visible or known defect that affects safe operation shall be used.

..1917.45(e)

1917.45(e)

Protective devices.

1917.45(e)(1)

When exposed moving parts such as gears, chains and chain sprockets present a hazard to employees during crane and derrick operations, those parts shall be securely guarded.

1917.45(e)(2)

Crane hooks shall be latched or otherwise secured to prevent accidental load disengagement.

1917.45(f)

General.

1917.45(f)(1)

Operating controls.

1917.45(f)(1)(i)

Crane and derrick operating controls shall be clearly marked, or a chart indicating their function shall be posted at the operator's position.

1917.45(f)(1)(ii)

After October 3, 1984, overhead bridge and container gantry crane operating control levers shall be self-centering so that they will automatically move to the "off" position when the operator releases the control.

1917.45(f)(2)

Booms. Cranes with elevatable booms and without operable automatic limiting devices shall be provided with boom stops if boom elevation can exceed maximum design angles from the horizontal.

1917.45(f)(3)

Foot pedals. Foot pedals shall have a non-skid surface.

..1917.45(f)(4)

1917.45(f)(4)

Access. Ladders, stairways, stanchions, grab irons, foot steps or equivalent means shall be provided as necessary to ensure safe access to footwalks, cab platforms, the cab and any portion of the superstructure which employees must reach.

1917.45(f)(4)(i)

Footwalks shall be of rigid construction and shall be capable of supporting a load of 100 pounds (4.79 kPa) per square foot.

1917.45(f)(4)(ii)

If more than 20 feet (6.1 m) in height, vertical ladders shall comply with 1917.118 (d), (e)(1), (e)(2)(iii), and (e)(2)(iv).

1917.45(f)(4)(iii)

Stairways on cranes shall be equipped with rigid handrails meeting the requirements of

1917.112(e).

1917.45(f)(4)(iv)

If the top of a ladder or stairway or any position thereof is located where a moving part of a crane, such as a revolving house, could strike an employee ascending or descending the ladder or stairway, a prominent warning sign shall be posted at the foot of the ladder or stairway. A system of communication (such as a buzzer or bell) shall be established and maintained between the foot of the ladder or stairway and the operator's cab.

1917.45(f)(5)

Operator's station.

1917.45(f)(5)(i)

The cab, controls and mechanism of the equipment shall be so arranged that the operator has a clear view of the load or signalman, when one is used. Cab glass, when used, shall be safety plate glass or equivalent. Cranes with missing, broken, cracked, scratched, or dirty glass (or equivalent) that impairs operator visibility shall not be used. Clothing, tools and equipment shall be stored so as not to interfere with access, operation, and the operator's view.

1917.45(f)(5)(ii)

A seat (lap) belt, meeting the requirements of 49 CFR 571.208-210 for a Type 1 seat belt assembly, shall be installed on the operator's seat of high speed container gantry cranes where the seat trolleys.

..1917.45(f)(6)

1917.45(f)(6)

Counterweights or ballast. Cranes shall be operated only with the specified type and amount of ballast or counterweights. Ballast or counterweight shall be located and secured only as provided in the manufacturer's or design specifications, which shall be available.

1917.45(f)(7)

Outriggers. Outriggers shall be used according to the manufacturers' specifications or design data, which shall be available. Floats, when used, shall be securely attached to the outriggers. Wood blocks or other support shall be of sufficient size to support the outrigger, free of defects that may affect safety and of sufficient width and length to prevent the crane from shifting or toppling under load.

1917.45(f)(8)

Exhaust gases. Engine exhaust gases shall be discharged away from the normal position of

crane operating personnel.

1917.45(f)(9)

Electrical equipment shall be so located or enclosed that live parts will not be exposed to accidental contact. Designated persons may work on energized equipment only if necessary during inspection, maintenance, or repair.

1917.45(f)(10)

Fire extinguisher.

1917.45(f)(10)(i)

At least one portable fire extinguisher of at least 5 - BC rating or equivalent shall be accessible in the cab of the crane or derrick.

1917.45(f)(10)(ii)

No portable fire extinguisher using carbon tetrachloride or chlorobromomethane extinguishing agents shall be used.

..1917.45(f)(11)

1917.45(f)(11)

Rope on drums. At least three full turns of rope shall remain on ungrooved drums, and two turns on grooved drums, under all operating conditions. Wire rope shall be secured to drums by clamps, U-bolts, shackles or equivalent means. Fiber rope fastenings are prohibited.

1917.45(f)(12)

Assembly or disassembly of boom sections. Mobile crane booms being assembled or disassembled on the ground with or without the support of the boom harness shall be blocked to prevent dropping of the boom or boom sections.

1917.45(f)(13)

Brakes.

1917.45(f)(13)(i)

Each independent hoisting unit of a crane shall be equipped with at least one holding brake, applied directly to the motor shaft or gear train.

1917.45(f)(13)(ii)

Each independent hoisting unit of a crane, except worm geared hoists, the angle of whose

worm is such as to prevent the load from accelerating in the lowering direction, shall, in addition to a holding brake, be equipped with a controlled braking means to control lowering speeds.

1917.45(f)(13)(iii)

Holding brakes for hoist units shall have not less than the following percentage of the rated load hoisting torque at the point where the brake is applied:

1917.45(f)(13)(iii)(A)

125 percent when used with an other than mechanically controlled braking means; or

1917.45(f)(13)(iii)(B)

100 percent when used with a mechanically-controlled braking means.

..1917.45(f)(13)(iii)(C)

1917.45(f)(13)(iii)(C)

100 percent when two holding brakes are provided.

1917.45(f)(13)(iv)

All power control braking means shall be capable of maintaining safe lowering speeds of rated loads.

1917.45(g)

Rail-mounted cranes (excluding locomotive types).

1917.45(g)(1)

For the purposes of this section, rail-mounted cranes include bridge ,cranes and portal cranes.

1917.45(g)(2)

Rated load marking. The rated loads of bridge cranes shall be plainly marked on each side of the crane and In the cab. If there is more than one hoisting unit, each hoist shall have its rated load marked on it or on its load block. Marking shall be legible from the ground level.

1917.45(g)(3)

Wind-indicating devices.

1917.45(g)(3)(i)

After October 3, 1983, each rail-mounted bridge and portal crane located outside of an enclosed structure shall be fitted with an operable wind-indicating device.

1917.45(g)(3)(ii)

The wind indicating device shall provide a visible or audible warning to alert the operator of high wind conditions. That warning shall be transmitted whenever the following circumstances are present:

..1917.45(g)(3)(ii)(A)

1917.45(g)(3)(ii)(A)

When wind velocity reaches the warning speed, not exceeding the crane manufacturer's recommendations; and

1917.45(g)(3)(ii)(B)

When wind velocity reaches the shutdown speed, not exceeding the crane manufacturer's recommendations, at which work is to be stopped and the crane secured.

1917.45(g)(3)(iii)

Instructions. The employer shall post operating instructions for high wind conditions in the operator's cab of each crane. Operators shall be directed to comply with these instructions. The instructions shall include procedures for responding to high wind alerts and for any coordination necessary with other cranes.

1917.45(g)(4)

Securing of cranes in high winds.

1917.45(g)(4)(i)

When the wind reaches the cranes warning speed:

1917.45(g)(4)(i)(A)

Gantry travel shall be stopped; and

1917.45(g)(4)(i)(B)

The crane shall be readied for shutdown.

1917.45(g)(4)(ii)

When the wind reaches the crane's shutdown speed:

1917.45(g)(4)(ii)(A)

Any portion of the crane spanning or partially spanning a vessel shall be moved clear of the vessel if safe to do so; and

..1917.45(g)(4)(ii)(B)

1917.45(g)(4)(ii)(B)

The crane shall be secured against travel, using all available means of securing.

1917.45(g)(5)

The employer shall monitor local weather conditions by subscribing to a weather service or using equally effective means.

1917.45(g)(6)

Stops and bumpers.

1917.45(g)(6)(i)

The ends of all tracks shall be equipped with stops or bumpers. If a stop engages the tread of the wheel, it shall be of a height not less than the radius of the wheel.

1917.45(g)(6)(ii)

When more than one crane operates on the same runway or more than one trolley on the same bridge, each crane or trolley shall be equipped with bumpers or equivalent devices at adjacent ends subject to impact.

1917.45(g)(7)

Employee exposure to crane movement. When employees may be in the vicinity of the tracks, crane trucks shall be equipped with personnel deflecting guards.

1917.45(g)(8)

Pedestrian clearance. If the track area is used for employee passage or for work, a minimum clearance of three feet (.91 m) shall be provided between trucks or the structures of rail-mounted cranes and any other structure or obstruction. When the required clearance is not available on at least one side of the crane's trucks, the area shall not be used and shall be marked and identified.

..1917.45(g)(9)

1917.45(g)(9)

Warning devices. Rail-mounted cranes shall be equipped with an effective travel warning device which shall be used to warn employees who may be in the path of the moving crane.

1917.45(g)(10)

Communications. Means of communication shall be provided between the operator's cab and the base of the gantry of all rail-mounted cranes. This requirement may be met by telephone, radio, sound-signalling system or other effective methods, but not solely by hand-signalling.

1917.45(g)(11)

Limit switch bypass systems shall be secured during all cargo operations. Such bypass systems shall not be used except in an emergency or during non-cargo handling operations such as stowing cranes or derricks or performing repairs. When a situation requiring the use of a bypass system or the readjustment of a limit switch arises, it shall be done only under the direction of a crane mechanic.

1917.45(h)

Stabilizing of locomotive cranes. Loads may be hoisted by locomotive cranes only if outriggers are in place, unless means are taken to prevent the load being carried by the truck springs of the crane.

1917.45(i)

Operations.

1917.45(i)(1)

Use of cranes together. When two or more cranes hoist a load in unison, a designated person shall direct the operation and instruct personnel in positioning, rigging of the load and movements to be made.

1917.45(i)(2)

Guarding of swing radius. Accessible areas within the swing radius of the body of a revolving crane shall be physically guarded during operations to prevent an employee from being caught between the body of the crane and any fixed structure or between parts of the crane.

..1917.45(i)(3)

1917.45(i)(3)

Securing mobile crane components in transit. The crane's super structure and boom shall be secured against rotation and carried in line with the direction of travel except when negotiating turns with an operator in the cab or when the boom is supported on a dolly. The

empty hook or other attachment shall be secured.

1917.45(i)(4)

Unattended cranes. the following steps shall be taken before leaving a crane unattended between work periods:

1917.45(i)(4)(i)

Suspended loads, such as those hoisted by lifting magnets or clamshell buckets, shall be landed unless the storage position or maximum hoisting of the suspended device will provide equivalent safety;

1917.45(i)(4)(ii)

Clutches shall be disengaged;

1917.45(i)(4)(iii)

The power supply shall be shut off;

1917.45(i)(4)(iv)

The crane shall be secured against accidental travel; and

1917.45(i)(4)(v)

The boom shall be lowered or secured against movement.

1917.45(i)(5)

Operating near electric power lines.

1917.45(i)(5)(i)

Clearance. Unless electrical distribution and transmission lines are de-energized and visibly grounded at the point of work, or unless insulating barriers not a part of or attached to the crane have been erected to prevent physical contact with lines, cranes may be operated near power lines only in accordance with the following:

..1917.45(i)(5)(i)(A)

1917.45(i)(5)(i)(A)

For lines rated 50 kV or below, minimum clearance between the lines and any part of the crane or load shall be 10 feet (3.05 m);

1917.45(i)(5)(i)(B)

For lines rated over 50 kV, minimum clearance between the lines and any part of the crane or load shall be either 10 feet (3.05 m) plus 0.4 inch (10.16 mm) for each 1 kV over 50 kV, or twice the length of the line insulator, but never less than 10 feet; and

1917.45(i)(5)(i)(C)

In transit with no load and boom lowered, the clearance shall be a minimum of 4 feet (1.22 m).

1917.45(i)(5)(ii)

Boom guards. Cage-type boom guards, insulating links or proximity warning devices may be used on cranes, but they shall not be used in place of the clearances required by paragraph (i)(5)(i) of this section.

1917.45(i)(5)(iii)

Determination of energized lines. Any overhead line shall be presumed to be energized until the owner of the line indicates that it is not energized.

1917.45(j)

Protection for employees being hoisted.

1917.45(j)(1)

No employee shall be hoisted by the load hoisting apparatus of a crane or derrick except:

1917.45(j)(1)(i)

On intermodal container spreaders, equipped in accordance with paragraph (j)(8) of this section; or

..1917.45(j)(1)(ii)

1917.45(j)(1)(ii)

In a boatswain's chair or other device rigged to prevent it from accidental disengagement from the hook or supporting member; or

1917.45(j)(1)(iii)

On a platform meeting the following requirements:

1917.45(j)(1)(iii)(A)

Enclosed by a railing or other means providing protection equivalent tot hat described in 1917.112(c). If equipped with open railings, the platform shall be fitted with toe boards;

1917.45(j)(1)(iii)(B)

Having a safety factor of four based on ultimate strength;

1917.45(j)(1)(iii)(C)

Bearing a plate or permanent marking indicating maximum load rating, which shall not be exceeded, and the weight of the platform itself;

1917.45(j)(1)(iii)(D)

Equipped with a device to prevent access doors, when used, from opening accidentally;

1917.45(j)(1)(iii)(E)

Equipped with overhead protection for employees on the platform if they are exposed to falling objects or overhead hazards;

1917.45(j)(1)(iii)(F)

Secured to the load line by means other than wedge and socket attachments, unless the free (bitter) end of the line is secured back to itself by a clamp placed as close above the wedge as possible.

..1917.45(j)(2)

1917.45(j)(2)

Except in an emergency, the hoisting mechanism of all cranes or derricks used to hoist personnel shall operate only in power up and power down, with automatic brake application when not hoisting or lowering.

1917.45(j)(3)

Variable radius booms of a crane or derrick used to hoist personnel shall be so constructed or secured as to prevent accidental boom movement.

1917.45(j)(4)

Platforms or devices used to hoist employees shall be inspected for defects before each day's use and shall be removed from service if defective.

1917.45(j)(5)

Employees being hoisted shall remain in continuous sight of and communication with the

operator or signalman.

1917.45(j)(6)

Operators shall remain at the controls when employees are hoisted.

1917.45(j)(7)

Cranes shall not travel while employees are hoisted, except in emergency or in normal tier to tier transfer of employees during container operations.

..1917.45(j)(8)

1917.45(j)(8)

When intermodal container spreaders are used to transfer employees to or from the tops of containers, the spreaders shall be equipped with a personnel platform equipped with fixed railings, provided that the railings have one or more openings for access. The openings shall be fitted with a means of closure, such as chains with hooks. Existing railings shall be at least 36 inches (0.91 m) in height. New railings installed after October 3, 1983 shall be 42 inches (1.07 m), plus or minus 3 inches (7.62 cm), in height. The provisions of paragraphs (j)(1)(iii)(C), (j)(1)(iii)(D), and (j)(1)(iii)(F) of this section also apply to personnel platforms when such container spreaders are used.

1917.45(j)(9)

Employees shall not be hoisted on intermodal container spreaders while a load is engaged.

1917.45(j)(10)

All cranes and derricks used to hoist personnel shall be equipped with an anti-two-blocking device.

1917.45(k)

Routine inspection.

1917.45(k)(1)

Designated persons shall visually inspect each crane and derrick on each day of use for defects in functional operating components and shall report any defect found to the employer. the employer shall inform the operator of the findings.

1917.45(k)(2)

A designated person shall thoroughly inspect all functional components and accessible structural features of each crane or device at monthly intervals.

1917.45(k)(3)

Any defects found during such inspections which may create a safety hazard shall be corrected before further equipment use. Repairs shall be performed only by designated persons.

1917.45(k)(4)

A record of monthly inspections shall be maintained for six months in or on the crane or derrick or at the terminal.

[62 FR 40141, July 25, 1997; 65 FR 40940, June 30, 2000]

OSHA 1926.550

Cranes and Derricks in the Construction Industry

Cranes and derricks. - 1926.550

Regulations (Standards - 29 CFR) - Table of Contents

- **Part Number:** 1926
- **Part Title:** Safety and Health Regulations for Construction
- **Subpart:** N
- **Subpart Title:** Cranes, Derricks, Hoists, Elevators, and Conveyors
- **Standard Number:** 1926.550
- **Title:** Cranes and derricks.

1926.550(a)

General requirements.

1926.550(a)(1)

The employer shall comply with the manufacturer's specifications and limitations applicable to the operation of any and all cranes and derricks. Where manufacturer's specifications are not available, the limitations assigned to the equipment shall be based on the determinations of a qualified engineer competent in this field and such determinations will be appropriately documented and recorded. Attachments used with cranes shall not exceed the capacity, rating, or scope recommended by the manufacturer.

1926.550(a)(2)

Rated load capacities, and recommended operating speeds, special hazard warnings, or instruction, shall be conspicuously posted on all equipment. Instructions or warnings shall be visible to the operator while he is at his control station.

1926.550(a)(3)

[Reserved]

1926.550(a)(4)

Hand signals to crane and derrick operators shall be those prescribed by the applicable ANSI standard for the type of crane in use. An illustration of the signals shall be posted at the job site.

..1926.550(a)(5)

1926.550(a)(5)

The employer shall designate a competent person who shall inspect all machinery and equipment prior to each use, and during use, to make sure it is in safe operating condition.

Any deficiencies shall be repaired, or defective parts replaced, before continued use.

1926.550(a)(6)

A thorough, annual inspection of the hoisting machinery shall be made by a competent person, or by a government or private agency recognized by the U.S. Department of Labor. The employer shall maintain a record of the dates and results of inspections for each hoisting machine and piece of equipment.

1926.550(a)(7)

Wire rope shall be taken out of service when any of the following conditions exist:

1926.550(a)(7)(i)

In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay;

1926.550(a)(7)(ii)

Wear of one-third the original diameter of outside individual wires. Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure;

1926.550(a)(7)(iii)

Evidence of any heat damage from any cause;

..1926.550(a)(7)(iv)

1926.550(a)(7)(iv)

Reductions from nominal diameter of more than one-sixty-fourth inch for diameters up to and including five-sixteenths inch, one-thirty-second inch for diameters three-eighths inch to and including one-half inch, three-sixty-fourths inch for diameters nine-sixteenths inch to and including three-fourths inch, one-sixteenth inch for diameters seven-eighths inch to 1 1/8 inches inclusive, three-thirty-seconds inch for diameters 1 1/4 to 1 1/2 inches inclusive;

1926.550(a)(7)(v)

In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

1926.550(a)(7)(vi)

Wire rope safety factors shall be in accordance with American National Standards Institute B 30.5-1968 or SAE J959-1966.

1926.550(a)(8)

Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, or other reciprocating, rotating, or other moving parts or equipment shall be guarded if such parts are exposed to contact by employees, or otherwise create a hazard. Guarding shall meet the requirements of the American National Standards Institute B 15.1-1958 Rev., Safety Code for Mechanical Power Transmission Apparatus.

1926.550(a)(9)

Accessible areas within the swing radius of the rear of the rotating superstructure of the crane, either permanently or temporarily mounted, shall be barricaded in such a manner as to prevent an employee from being struck or crushed by the crane.

1926.550(a)(10)

All exhaust pipes shall be guarded or insulated in areas where contact by employees is possible in the performance of normal duties.

..1926.550(a)(11)

1926.550(a)(11)

Whenever internal combustion engine powered equipment exhausts in enclosed spaces, tests shall be made and recorded to see that employees are not exposed to unsafe concentrations of toxic gases or oxygen deficient atmospheres.

1926.550(a)(12)

All windows in cabs shall be of safety glass, or equivalent, that introduces no visible distortion that will interfere with the safe operation of the machine.

1926.550(a)(13)

1926.550(a)(13)(i)

Where necessary for rigging or service requirements, a ladder, or steps, shall be provided to give access to a cab roof.

1926.550(a)(13)(ii)

Guardrails, handholds, and steps shall be provided on cranes for easy access to the car and cab, conforming to American National Standards Institute B30.5.

1926.550(a)(13)(iii)

Platforms and walkways shall have anti-skid surfaces.

1926.550(a)(14)

Fuel tank filler pipe shall be located in such a position, or protected in such manner, as to not allow spill or overflow to run onto the engine, exhaust, or electrical equipment of any machine being fueled.

1926.550(a)(14)(i)

An accessible fire extinguisher of 5BC rating, or higher, shall be available at all operator stations or cabs of equipment.

..1926.550(a)(14)(ii)

1926.550(a)(14)(ii)

All fuels shall be transported, stored, and handled to meet the rules of Subpart F of this part. When fuel is transported by vehicles on public highways, Department of Transportation rules contained in 49 CFR Parts 177 and 393 concerning such vehicular transportation are considered applicable.

1926.550(a)(15)

Except where electrical distribution and transmission lines have been deenergized and visibly grounded at point of work or where insulating barriers, not a part of or an attachment to the equipment or machinery, have been erected to prevent physical contact with the lines, equipment or machines shall be operated proximate to power lines only in accordance with the following:

1926.550(a)(15)(i)

For lines rated 50 kV. or below, minimum clearance between the lines and any part of the crane or load shall be 10 feet;

1926.550(a)(15)(ii)

For lines rated over 50 kV., minimum clearance between the lines and any part of the crane or load shall be 10 feet plus 0.4 inch for each 1 kV. over 50 kV., or twice the length of the line insulator, but never less than 10 feet;

1926.550(a)(15)(iii)

In transit with no load and boom lowered, the equipment clearance shall be a minimum of 4 feet for voltages less than 50 kV., and 10 feet for voltages over 50 kV., up to and including 345 kV., and 16 feet for voltages up to and including 750 kV.

1926.550(a)(15)(iv)

A person shall be designated to observe clearance of the equipment and give timely warning

for all operations where it is difficult for the operator to maintain the desired clearance by visual means;

..1926.550(a)(15)(v)

1926.550(a)(15)(v)

Cage-type boom guards, insulating links, or proximity warning devices may be used on cranes, but the use of such devices shall not alter the requirements of any other regulation of this part even if such device is required by law or regulation;

1926.550(a)(15)(vi)

Any overhead wire shall be considered to be an energized line unless and until the person owning such line or the electrical utility authorities indicate that it is not an energized line and it has been visibly grounded;

1926.550(a)(15)(vii)

Prior to work near transmitter towers where an electrical charge can be induced in the equipment or materials being handled, the transmitter shall be de-energized or tests shall be made to determine if electrical charge is induced on the crane. The following precautions shall be taken when necessary to dissipate induced voltages:

1926.550(a)(15)(vii)(a)

The equipment shall be provided with an electrical ground directly to the upper rotating structure supporting the boom; and

1926.550(a)(15)(vii)(b)

Ground jumper cables shall be attached to materials being handled by boom equipment when electrical charge is induced while working near energized transmitters. Crews shall be provided with nonconductive poles having large alligator clips or other similar protection to attach the ground cable to the load.

1926.550(a)(15)(vii)(c)

Combustible and flammable materials shall be removed from the immediate area prior to operations.

..1926.550(a)(16)

1926.550(a)(16)

No modifications or additions which affect the capacity or safe operation of the equipment shall be made by the employer without the manufacturer's written approval. If such modifications or changes are made, the capacity, operation, and maintenance instruction

plates, tags, or decals, shall be changed accordingly. In no case shall the original safety factor of the equipment be reduced.

1926.550(a)(17)

The employer shall comply with Power Crane and Shovel Association Mobile Hydraulic Crane Standard No. 2.

1926.550(a)(18)

Sideboom cranes mounted on wheel or crawler tractors shall meet the requirements of SAE J743a-1964.

1926.550(a)(19)

All employees shall be kept clear of loads about to be lifted and of suspended loads.

1926.550(b)

Crawler, locomotive, and truck cranes.

1926.550(b)(1)

All jibs shall have positive stops to prevent their movement of more than 5 deg above the straight line of the jib and boom on conventional type crane booms. The use of cable type belly slings does not constitute compliance with this rule.

..1926.550(b)(2)

1926.550(b)(2)

All crawler, truck, or locomotive cranes in use shall meet the applicable requirements for design, inspection, construction, testing, maintenance and operation as prescribed in the ANSI B30.5-1968, Safety Code for Crawler, Locomotive and Truck Cranes. However, the written, dated, and signed inspection reports and records of the monthly inspection of critical items prescribed in section 5-2.1.5 of the ANSI B30.5-1968 standard are not required. Instead, the employer shall prepare a certification record which includes the date the crane items were inspected; the signature of the person who inspected the crane items; and a serial number, or other identifier, for the crane inspected. The most recent certification record shall be maintained on file until a new one is prepared.

1926.550(c)

Hammerhead tower cranes.

1926.550(c)(1)

Adequate clearance shall be maintained between moving and rotating structures of the crane

and fixed objects to allow the passage of employees without harm.

1926.550(c)(2)

Each employee required to perform duties on the horizontal boom of hammerhead tower cranes shall be protected against falling by guardrails or by a personal fall arrest system in conformance with subpart M of this part.

1926.550(c)(3)

Buffers shall be provided at both ends of travel of the trolley.

1926.550(c)(4)

Cranes mounted on rail tracks shall be equipped with limit switches limiting the travel of the crane on the track and stops or buffers at each end of the tracks.

1926.550(c)(5)

All hammerhead tower cranes in use shall meet the applicable requirements for design, construction, installation, testing, maintenance, inspection, and operation as prescribed by the manufacturer.

..1926.550(d)

1926.550(d)

Overhead and gantry cranes.

1926.550(d)(1)

The rated load of the crane shall be plainly marked on each side of the crane, and if the crane has more than one hoisting unit, each hoist shall have its rated load marked on it or its load block, and this marking shall be clearly legible from the ground or floor.

1926.550(d)(2)

Bridge trucks shall be equipped with sweeps which extend below the top of the rail and project in front of the truck wheels.

1926.550(d)(3)

Except for floor-operated cranes, a gong or other effective audible warning signal shall be provided for each crane equipped with a power traveling mechanism.

1926.550(d)(4)

All overhead and gantry cranes in use shall meet the applicable requirements for design,

construction, installation, testing, maintenance, inspection, and operation as prescribed in the ANSI B30.2.0-1967, Safety Code for Overhead and Gantry Cranes.

1926.550(e)

Derricks. All derricks in use shall meet the applicable requirements for design, construction, installation, inspection, testing, maintenance, and operation as prescribed in American National Standards Institute B30.6-1969, Safety Code for Derricks.

1926.550(f)

Floating cranes and derricks -

1926.550(f)(1)

Mobile cranes mounted on barges.

1926.550(f)(1)(i)

When a mobile crane is mounted on a barge, the rated load of the crane shall not exceed the original capacity specified by the manufacturer.

..1926.550(f)(1)(ii)

1926.550(f)(1)(ii)

A load rating chart, with clearly legible letters and figures, shall be provided with each crane, and securely fixed at a location easily visible to the operator.

1926.550(f)(1)(iii)

When load ratings are reduced to stay within the limits for list of the barge with a crane mounted on it, a new load rating chart shall be provided.

1926.550(f)(1)(iv)

Mobile cranes on barges shall be positively secured.

1926.550(f)(2)

Permanently mounted floating cranes and derricks.

1926.550(f)(2)(i)

When cranes and derricks are permanently installed on a barge, the capacity and limitations of use shall be based on competent design criteria.

1926.550(f)(2)(ii)

A load rating chart with clearly legible letters and figures shall be provided and securely fixed at a location easily visible to the operator.

1926.550(f)(2)(iii)

Floating cranes and floating derricks in use shall meet the applicable requirements for design, construction, installation, testing, maintenance, and operation as prescribed by the manufacturer.

1926.550(f)(3)

Protection of employees working on barges. The employer shall comply with the applicable requirements for protection of employees working onboard marine vessels specified in 1926.605.

..1926.550(g)

1926.550(g)

Crane or derrick suspended personnel platforms -

1926.550(g)(1)

Scope, application and definitions -

1926.550(g)(1)(i)

Scope and application. This standard applies to the design, construction, testing, use and maintenance of personnel platforms, and the hoisting of personnel platforms on the load lines of cranes or derricks.

1926.550(g)(1)(ii)

Definitions. For the purposes of this paragraph (g), the following definitions apply:

1926.550(g)(1)(ii)(A)

"Failure" means load refusal, breakage, or separation of components.

1926.550(g)(1)(ii)(B)

"Hoist" (or hoisting) means all crane or derrick functions such as lowering, lifting, swinging, booming in and out or up and down, or suspending a personnel platform.

1926.550(g)(1)(ii)(C)

"Load refusal" means the point where the ultimate strength is exceeded.

1926.550(g)(1)(ii)(D)

"Maximum intended load" means the total load of all employees, tools, materials, and other loads reasonably anticipated to be applies to a personnel platform or personnel platform component at any one time.

1926.550(g)(1)(ii)(E)

"Runway" means a firm, level surface designed, prepared and designated as a path of travel for the weight and configuration of the crane being used to lift and travel with the crane suspended platform. An existing surface may be used as long as it meets these criteria.

..1926.550(g)(2)

1926.550(g)(2)

General requirements. The use of a crane or derrick to hoist employees on a personnel platform is prohibited, except when the erection, use, and dismantling of conventional means of reaching the worksite, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible because of structural design or worksite conditions.

1926.550(g)(3)

Cranes and derricks -

1926.550(g)(3)(i)

Operational criteria.

1926.550(g)(3)(i)(A)

Hoisting of the personnel platform shall be performed in a slow, controlled, cautious manner with no sudden movements of the crane or derrick, or the platform.

1926.550(g)(3)(i)(B)

Load lines shall be capable of supporting, without failure, at least seven times the maximum intended load, except that where rotation resistant rope is used, the lines shall be capable of supporting without failure, at least ten times the maximum intended load. The required design factor is achieved by taking the current safety factor of 3.5 (required under 1926.550(b)(2) and applying the 50 per cent derating of the crane capacity which is required by 1926.550(g)(3)(i)(F).

1926.550(g)(3)(i)(C)

Load and boom hoist drum brakes, swing brakes, and locking devices such as pawls or dogs shall be engaged when the occupied personnel platform is in a stationary position.

1926.550(g)(3)(i)(D)

The crane shall be uniformly level within one percent of level grade and located on firm footing. Cranes equipped with outriggers shall have them all fully deployed following manufacturer's specifications, insofar as applicable, when hoisting employees.

..1926.550(g)(3)(i)(E)

1926.550(g)(3)(i)(E)

The total weight of the loaded personnel platform and related rigging shall not exceed 50 percent of the rated capacity for the radius and configuration of the crane or derrick.

1926.550(g)(3)(i)(F)

The use of machines having live booms (booms in which lowering is controlled by a brake without aid from other devices which slow the lowering speeds) is prohibited.

1926.550(g)(3)(ii)

Instruments and components.

1926.550(g)(3)(ii)(A)

Cranes and derricks with variable angle booms shall be equipped with a boom angle indicator, readily visible to the operator.

1926.550(g)(3)(ii)(B)

Cranes with telescoping booms shall be equipped with a device to indicate clearly to the operator, at all times, the boom's extended length or an accurate determination of the load radius to be used during the lift shall be made prior to hoisting personnel.

1926.550(g)(3)(ii)(C)

A positive acting device shall be used which prevents contact between the load block or overhaul ball and the boom tip (anti-two-blocking device), or a system shall be used which deactivates the hoisting action before damage occurs in the event of a two-blocking situation (two-block damage prevention feature).

..1926.550(g)(3)(ii)(D)

1926.550(g)(3)(ii)(D)

The load line hoist drum shall have a system or device on the power train, other than the load

hoist brake, which regulates the lowering rate of speed of the hoist mechanism (controlled load lowering.) Free fall is prohibited.

1926.550(g)(4)

Personnel Platforms. -

1926.550(g)(4)(i)

Design criteria.

1926.550(g)(4)(i)(A)

The personnel platform and suspension system shall be designed by a qualified engineer or a qualified person competent in structural design.

1926.550(g)(4)(i)(B)

The suspension system shall be designed to minimize tipping of the platform due to movement of employees occupying the platform.

1926.550(g)(4)(i)(C)

The personnel platform itself, except the guardrail system and personnel fall arrest system anchorages, shall be capable of supporting, without failure, its own weight and at least five times the maximum intended load. Criteria for guardrail systems and personal fall arrest system anchorages are contained in subpart M of this Part.

1926.550(g)(4)(ii)

Platform specifications.

1926.550(g)(4)(ii)(A)

Each personnel platform shall be equipped with a guardrail system which meets the requirements of Subpart M, and shall be enclosed at least from the toeboard to mid-rail with either solid construction or expanded metal having openings no greater than 1/2 inch (1.27 cm).

1926.550(g)(4)(ii)(B)

A grab rail shall be installed inside the entire perimeter of the personnel platform.

..1926.550(g)(4)(ii)(C)

1926.550(g)(4)(ii)(C)

Access gates, if installed, shall not swing outward during hoisting.

1926.550(g)(4)(ii)(D)

Access gates, including sliding or folding gates, shall be equipped with a restraining device to prevent accidental opening.

1926.550(g)(4)(ii)(E)

Headroom shall be provided which allows employees to stand upright in the platform.

1926.550(g)(4)(ii)(F)

In addition to the use of hard hats, employees shall be protected by overhead protection on the personnel platform when employees are exposed to falling objects.

1926.550(g)(4)(ii)(G)

All rough edges exposed to contact by employees shall be surfaced or smoothed in order to prevent injury to employees from punctures or lacerations.

1926.550(g)(4)(ii)(H)

All welding of the personnel platform and its components shall be performed by a qualified welder familiar with the weld grades, types and material specified in the platform design.

1926.550(g)(4)(ii)(I)

The personnel platform shall be conspicuously posted with a plate or other permanent marking which indicates the weight of the platform, and its rated load capacity or maximum intended load.

..1926.550(g)(4)(iii)

1926.550(g)(4)(iii)

Personnel platform loading.

1926.550(g)(4)(iii)(A)

The personnel platform shall not be loaded in excess of its rated load capacity, When a personnel platform does not have a rated load capacity then the personnel platform shall not be loaded in excess of its maximum intended load.

1926.550(g)(4)(iii)(B)

The number of employees occupying the personnel platform shall not exceed the number

required for the work being performed.

1926.550(g)(4)(iii)(C)

Personnel platforms shall be used only for employees, their tools and the materials necessary to do their work, and shall not be used to hoist only materials or tools when not hoisting personnel.

1926.550(g)(4)(iii)(D)

Materials and tools for use during a personnel lift shall be secured to prevent displacement.

1926.550(g)(4)(iii)(E)

Materials and tools for use during a personnel lift shall be evenly distributed within the confines of the platform while the platform is suspended.

1926.550(g)(4)(iv)

Rigging.

1926.550(g)(4)(iv)(A)

When a wire rope bridle is used to connect the personnel platform to the load line, each bridle leg shall be connected to a master link or shackle in such a manner to ensure that the load is evenly divided among the bridle legs.

..1926.550(g)(4)(iv)(B)

1926.550(g)(4)(iv)(B)

Hooks on overhaul ball assemblies, lower load blocks, or other attachment assemblies shall be of a type that can be closed and locked, eliminating the hook throat opening. Alternatively, an alloy anchor type shackle with a bolt, nut and retaining pin may be used.

1926.550(g)(4)(iv)(C)

Wire rope, shackles, rings, master links, and other rigging hardware must be capable of supporting, without failure, at least five times the maximum intended load applied or transmitted to that component. Where rotation resistant rope is used, the slings shall be capable of supporting without failure at least ten times the maximum intended load.

1926.550(g)(4)(iv)(D)

All eyes in wire rope slings shall be fabricated with thimbles.

1926.550(g)(4)(iv)(E)

Bridles and associated rigging for attaching the personnel platform to the hoist line shall be used only for the platform and the necessary employees, their tools and the materials necessary to do their work and shall not be used for any other purpose when not hoisting personnel.

..1926.550(g)(5)

1926.550(g)(5)

Trial lift, inspections and proof testing.

1926.550(g)(5)(i)

A trial lift with the unoccupied personnel platform loaded at least to the anticipated lift weight shall be made from ground level, or any other location where employees will enter the platform to each location at which the personnel platform is to be hoisted and positioned. This trial lift shall be performed immediately prior to placing personnel on the platform. The operator shall determine that all systems, controls and safety devices are activated and functioning properly; that no interferences exist; and that all configurations necessary to reach those work locations will allow the operator to remain under the 50 percent limit of the hoist's rated capacity. Materials and tools to be used during the actual lift can be loaded in the platform, as provided in paragraphs (g)(4)(iii)(D), and (E) of this section for the trial lift. A single trial lift may be performed at one time for all locations that are to be reached from a single set up position.

1926.550(g)(5)(ii)

The trial lift shall be repeated prior to hoisting employees whenever the crane or derrick is moved and set up in a new location or returned to a previously used location. Additionally , the trial lift shall be repeated when the lift route is changed unless the operator determines that the route change is not significant (i.e. the route change would not affect the safety of hoisted employees.)

1926.550(g)(5)(iii)

After the trial lift, and just prior to hoisting personnel, the platform shall be hoisted a few inches and inspected to ensure that it is secure and properly balanced. Employees shall not be hoisted unless the following conditions are determined to exist:

1926.550(g)(5)(iii)(A)

Hoist ropes shall be free of kinks;

1926.550(g)(5)(iii)(B)

Multiple part lines shall not be twisted around each other;

1926.550(g)(5)(iii)(C)

The primary attachment shall be centered over the platform, and

1926.550(g)(5)(iii)(D)

The hoisting system shall be inspected if the load rope is slack to ensure all ropes are properly stated on drums and in sheaves.

..1926.550(g)(5)(iv)

1926.550(g)(5)(iv)

A visual inspection of the crane or derrick, rigging, personnel platform, and the crane or derrick base support or ground shall be conducted by a competent person immediately after the trial lift to determine whether the testing has exposed any defect or produced any adverse effect upon any component or structure.

1926.550(g)(5)(v)

Any defects found during inspections which create a safety hazard shall be corrected before hoisting personnel.

1926.550(g)(5)(vi)

At each job site, prior to hoisting employees on the personnel platform, and after any repair or modification, the platform and rigging shall be proof tested to 125 percent of the platform's rated capacity by holding it in a suspended position for five minutes with the test load evenly distributed on the platform (this may be done concurrently with the trial lift). After proof testing, a competent person shall inspect the platform and rigging. Any deficiencies found shall be corrected and another proof test shall be conducted. Personnel hoisting shall not be conducted until the proof testing requirements are satisfied.

1926.550(g)(6)

Work practices.

1926.550(g)(6)(i)

Employees shall keep all parts of the body inside the platform during raising lowering, and positioning. This provision does not apply to an occupant of the platform performing the duties of a signal person.

1926.550(g)(6)(ii)

Before employees exit or enter a hoisted personnel platform that is not landed, the platform shall be secured to the structure where the work is to be performed, unless securing to the

structure creates an unsafe situation.

..1926.550(g)(6)(iii)

1926.550(g)(6)(iii)

Tag lines shall be used unless their use creates an unsafe condition.

1926.550(g)(6)(iv)

The crane or derrick operator shall remain at the controls at all times when the crane engine is running and the platform is occupied.

1926.550(g)(6)(v)

Hoisting of employees shall be promptly discontinued upon indication of any dangerous weather conditions or other impending danger.

1926.550(g)(6)(vi)

Employees being hoisted shall remain in continuous sight of and in direct communication with the operator or signal person. In those situations where direct visual contact with the operator is not possible, and the use of a signal person would create a greater hazard for the person, direct communication alone such as by radio may be used.

1926.550(g)(6)(vii)

Except over water, employees occupying the personnel platform shall use a body belt/harness system with lanyard appropriately attached to the lower load block or overhaul ball, or to a structural member within the personnel platform capable of supporting a fall impact for employees using the anchorage. When working over water the requirements of 1926.106 shall apply.

need a flotation device.

1926.550(g)(6)(viii)

No lifts shall be made on another of the crane's or derrick's loadlines while personnel are suspended on a platform.

..1926.550(g)(7)

1926.550(g)(7)

Traveling.

1926.550(g)(7)(i)

Hoisting of employees while the crane is traveling is prohibited, except for portal, tower and locomotive cranes, or where the employer demonstrates that there is no less hazardous way

to perform the work.

1926.550(g)(7)(ii)

Under any circumstances where a crane would travel while hoisting personnel, the employer shall implement the following procedures to safeguard employees:

1926.550(g)(7)(ii)(A)

Crane travel shall be restricted to a fixed track or runway;

1926.550(g)(7)(ii)(B)

Travel shall be limited to the load radius of the boom used during the lift; and

1926.550(g)(7)(ii)(C)

The boom must be parallel to the direction of travel.

1926.550(g)(7)(ii)(D)

A complete trial run shall be performed to test the route of travel before employees are allowed to occupy the platform. This trial run can be performed at the same time as the trial lift required by paragraph (g)(5)(i) of this section which tests the route of the lift.

1926.550(g)(7)(ii)(E)

If travel is done with a rubber tired-carrier, the condition and air pressure of the tires shall be checked. The chart capacity for lifts on rubber shall be used for application of the 50 percent reduction of rated capacity. Notwithstanding paragraph (g)(5)(i)(E) of this section, outriggers may be partially retracted as necessary for travel.

..1926.550(g)(8)

1926.550(g)(8)

Pre-lift meeting.

1926.550(g)(8)(i)

A meeting attended by the crane or derrick operator, signal person(s) (if necessary for the lift), employee(s) to be lifted, and the person responsible for the task to be performed shall be held to review the appropriate requirements of paragraph (g) of this section and the procedures to be followed.

1926.550(g)(8)(ii)

This meeting shall be held prior to the trial lift at each new work location, and shall be

repeated for any employees newly assigned to the operation.

[44 FR 8577, Feb. 9, 1979; 44 FR 20940, Apr. 6, 1979, as amended at 52 FR 36382, Sept. 28, 1987; 53 FR 29139, Aug. 2, 1988; 54 FR 15406, Apr. 18, 1989; 54 FR 24334, June 7, 1989; 58 FR 35183, June 30, 1993, 59 FR 40730, Aug. 9, 1994; 61 FR 5507, Feb. 13, 1996]

ANSI B30.26

Rigging Hardware

ASME B30.26-2004

Rigging Hardware

Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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The next edition of this Standard is scheduled for publication in 2007. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME Web site under the Committee Pages at http://www.asme.org/codes/ as they are issued, and will also be published within the next edition of the Standard.

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

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FOREWORD

This American National Standard, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, has been developed under the procedures accredited by the American National Standards Institute (formerly the United States of America Standards Institute). This Standard had its beginning in December 1916 when an eight-page Code of Safety Standards for Cranes, prepared by an ASME Committee on the Protection of Industrial Workers, was presented to the annual meeting of the ASME.

Meetings and discussions regarding safety on cranes, derricks, and hoists were held from 1920 to 1925, involving the ASME Safety Code Correlating Committee, the Association of Iron and Steel Electrical Engineers, the American Museum of Safety, the American Engineering Standards Committee (later changed to American Standards Association and subsequently to the USA Standards Institute), Department of Labor — State of New Jersey, Department of Labor and Industry — State of Pennsylvania, and the Locomotive Crane Manufacturers Association. On June 11, 1925, the American Engineering Standards Committee approved the ASME Safety Code Correlating Committee's recommendation and authorized the project with the U.S. Department of the Navy, Bureau of Yards and Docks, and ASME as sponsors.

In March 1926, invitations were issued to 50 organizations to appoint representatives to a Sectional Committee. The call for organization of this Sectional Committee was sent out October 2, 1926, and the committee organized November 4, 1926, with 57 members representing 29 national organizations. The Safety Code for Cranes, Derricks, and Hoists, ASA B30.2-1943, was created from the eight-page document referred to in the first paragraph. This document was reaffirmed in 1952 and widely accepted as a safety standard.

Due to changes in design, advancement in techniques, and general interest of labor and industry in safety, the Sectional Committee, under the joint sponsorship of ASME and the Naval Facilities Engineering Command, U.S. Department of the Navy, was reorganized as an American National Standards Committee on January 31, 1962, with 39 members representing 27 national organizations.

The format of the previous code was changed so that separate standards (each complete as to construction and installation; inspection, testing, and maintenance; and operation) will cover the different types of equipment included in the scope of B30.

In 1982, the Committee was reorganized as an Accredited Organization Committee, operating under procedures developed by the ASME and accredited by the American National Standards Institute.

This Standard presents a coordinated set of rules that may serve as a guide to government and other regulatory bodies and municipal authorities responsible for the guarding and inspection of the equipment falling within its scope. The suggestions leading to accident prevention are given both as mandatory and advisory provisions; compliance with both types may be required by employers of their employees.

In case of practical difficulties, new developments, or unnecessary hardship, the administrative or regulatory authority may grant variances from the literal requirements or permit the use of other devices or methods, but only when it is clearly evident that an equivalent degree of protection is thereby secured. To secure uniform application and interpretation of this Standard, administrative or regulatory authorities are urged to consult the B30 Committee, in accordance with the format described in Section III, before rendering decisions on disputed points.

This volume of the Standard, which was approved by the B30 Committee and by ASME, was approved by ANSI and designated as an American National Standard on December 2, 2004.

Safety codes and standards are intended to enhance public safety. Revisions result from committee consideration of factors such as technological advances, new data, and changing environmental and industry needs. Revisions do not imply that previous editions were inadequate.

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Safety Standards for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

(The following is the roster of the Committee at the time of approval of this Standard.)

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SAFETY STANDARD FOR CABLEWAYS, CRANES, DERRICKS, HOISTS, HOOKS, JACKS, AND SLINGS

B30 STANDARD INTRODUCTION

GENERAL

This Standard is one of a series of safety standards on various subjects that have been formulated under the general auspices of the American National Standards Institute. One purpose of the Standard is to serve as a guide to governmental authorities having jurisdiction over subjects within the scope of the Standard. It is expected, however, that the Standard will find a major application in industry, serving as a guide to manufacturers, purchasers, and users of the equipment.

For the convenience of the user, the Standard has been divided into separate volumes.

B30.1 Jacks
B30.2 Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
B30.3 Construction Tower Cranes
B30.4 Portal, Tower, and Pedestal Cranes
B30.5 Mobile and Locomotive Cranes
B30.6 Derricks
B30.7 Base Mounted Drum Hoists
B30.8 Floating Cranes and Floating Derricks
B30.9 Slings
B30.10 Hooks
B30.11 Monorails and Underhung Cranes
B30.12 Handling Loads Suspended From Rotorcraft
B30.13 Storage/Retrieval (S/R) Machines and Associated Equipment
B30.14 Side Boom Tractors
B30.15 Mobile Hydraulic Cranes
(NOTE: B30.15-1973 has been withdrawn. The revision of B30.15 is included in the latest edition of B30.5.)
B30.16 Overhead Hoists (Underhung)
B30.17 Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
B30.18 Stacker Cranes (Top or Under Running Bridge, Multiple Girder With Top or Under Running Trolley Hoist)
B30.19 Cableways
B30.20 Below-the-Hook Lifting Devices
B30.21 Manually Lever Operated Hoists
B30.22 Articulating Boom Cranes
B30.23 Personnel Lifting Systems
B30.24 Container Cranes[1]
B30.25 Scrap and Material Handlers
B30.26 Rigging Hardware
B30.27 Material Placement Systems[1]
B30.28 Balance-Lifting Units[1]

If these standards are adopted for governmental use, the references to other national codes and standards in the specific volumes may be changed to refer to the corresponding regulations of the governmental authorities.

The use of cableways, cranes, derricks, hoists, hooks, jacks, and slings is subject to certain hazards that cannot be met by mechanical means but only by the exercise of intelligence, care, and common sense. It is therefore essential to have personnel involved in the use and operation of equipment who are competent, careful, physically and mentally qualified, and trained in the safe operation of the equipment and the handling of the loads. Serious hazards are overloading, dropping or slipping of the load caused by improper hitching or slinging, obstructing the free passage of the load, and using equipment for a purpose for which it was not intended or designed.

The Standards Committee fully realizes the importance of proper design factors, minimum or maximum sizes, and other limiting dimensions of wire rope or chain and their fastenings, sheaves, sprockets, drums, and similar equipment covered by the Standard, all of which are closely connected with safety. Sizes, strengths, and similar criteria depend on many different factors, often varying with the installation and uses. These factors depend on the condition of the equipment or material; the loads; the acceleration or speed of the ropes, chains, sheaves, sprockets, or drums; the type of attachments; the number, size, and arrangement of sheaves or other parts; environmental conditions causing corrosion or wear; and many variables that must be considered in each individual case. The rules given in the Standard must be interpreted accordingly, and judgment must be used in determining their application.

The Standards Committee will be glad to receive criticisms of this Standard's requirements and suggestions

[1] B30.24, B30.27, and B30.28 are in the developmental stage.

for its improvement, especially those based on actual experience in application of the rules.

Suggestions for changes to the Standard should be submitted to the Secretary of the B30 Committee, ASME, Three Park Avenue, New York, NY 10016-5990, and should be in accordance with the following format:

(*a*) Cite the specific paragraph designation of the pertinent volume.

(*b*) Indicate the suggested change (addition, deletion, revision, etc.).

(*c*) Briefly state the reason and/or evidence for the suggested change.

(*d*) Submit suggested changes to more than one paragraph in the order that the paragraphs appear in the volume.

The B30 Committee will consider each suggested change in a timely manner in accordance with its procedures.

SECTION I: SCOPE OF B30 STANDARD

This Standard applies to the construction, installation, operation, inspection, maintenance, and safe use of lifting equipment used in construction and industrial settings. This includes, but is not limited to: articulating-boom, container, gantry, mobile, pedestal, portal, tower and stacker cranes; balance-lifting units; below-the-hook lifting devices; cableways; derricks; jacks; hoists; hooks; loads suspended from rotorcraft; material placement systems; monorails; rigging hardware; and scrap and material handlers.

This Standard does not apply to track and automotive jacks, railway or automobile wrecking cranes, shipboard cranes, shipboard cargo-handling equipment, well-drilling derricks, skip hoists, mine hoists, truck body hoists, car or barge pullers, conveyors, excavating equipment, or equipment falling within the scope of the following Committees: A10, A17, A90, A92, A120, B20, B56, and B77.

SECTION II: PURPOSE

This Standard is designed to

(*a*) guard against and minimize injury to workers, and otherwise provide for the protection of life, limb, and property by prescribing safety requirements

(*b*) provide direction to owners, employers, supervisors, and others concerned with, or responsible for, its application

(*c*) guide governments and other regulatory bodies in the development, promulgation, and enforcement of appropriate safety directives

SECTION III: INTERPRETATIONS

Upon request, the B30 Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B30 Committee, ASME, Three Park Avenue, New York, NY 10016-5990.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his request utilizing the following format.

Subject: Cite the applicable paragraph number(s) and provide a concise description.

Edition: Cite the applicable edition of the pertinent volume for which the interpretation is being requested.

Question: Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for approval of a proprietary design or situation. The inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain any proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which could change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

SECTION IV: NEW AND EXISTING INSTALLATIONS

(*a*) *Effective Date.* The effective date of this volume for the purpose of defining new and existing installations shall be 1 year after its date of issuance.

(*b*) *New Installations.* Construction, installation, inspection, testing, maintenance, and operation of equipment manufactured and facilities constructed after the effective date of this volume shall conform to the mandatory requirements of this volume.

(*c*) *Existing Installations.* Inspection, testing, maintenance, and operation of equipment manufactured and facilities constructed prior to the effective date of this volume shall be done, as applicable, in accordance with the requirements of this volume.

It is not the intent of this volume to require retrofitting of existing equipment. However, when an item is being modified, its performance requirement shall be reviewed relative to the current volume. If the performance differs substantially, the need to meet the current requirement shall be evaluated by a qualified person selected by the owner (user). Recommended changes shall be made by the owner (user) within 1 year.

SECTION V: MANDATORY AND ADVISORY RULES

Mandatory rules of this Standard are characterized by use of the word *shall*. If a provision is of an advisory nature, it is indicated by use of the word *should* and is a recommendation to be considered, the advisability of which depends on the facts in each situation.

SECTION VI: METRIC CONVERSIONS

This Standard contains SI (metric) units as well as U.S. Customary units. The values stated in U.S. Customary units are to be regarded as the standard. The SI units are a direct (soft) conversion from the customary units.

RIGGING HARDWARE

Chapter 26-0
Scope, Definitions, and References

SECTION 26-0.1: SCOPE

Volume B30.26 includes provisions that apply to the construction, installation, operation, inspection, and maintenance of detachable rigging hardware used for lifting purposes in conjunction with equipment described in other volumes of the B30 Standard. This hardware includes shackles, links, rings, swivels, turnbuckles, eyebolts, hoist rings, wire rope clips, wedge sockets, and rigging blocks. Use of the same hardware for purposes other than lifting is excluded from the provisions of this Volume.

SECTION 26-0.2: DEFINITIONS

abnormal operating conditions: environmental conditions that are unfavorable, harmful, or detrimental to or for the operation of a piece of detachable hardware, such as excessively high or low ambient temperatures; exposure to weather; corrosive fumes; dust laden or moisture laden atmospheres; and hazardous locations.

angle of loading: the acute angle between horizontal and the leg of the rigging, often referred to as the horizontal angle.

bow, shackle: the curved portion of the shackle body opposite the pin, often referred to as the bail, the body, the dee, or the bowl (see Fig. 3).

dead end: the section of wire rope that is not tensioned under load (see Figs. 10 and 11).

design factor: ratio between nominal or minimum breaking strength and rated load of the rigging hardware.

designated person: a person who is selected or assigned by the employer or employer's representative as being competent to perform specific duties.

ears, shackle: portion of the shackle body which supports the shackle pin (see Fig. 3).

hardware service:

normal: service that involves use of loads at or below the rated load.

severe: service that involves normal service coupled with abnormal rigging or operating conditions.

special: service that involves operation, other than normal or severe, which is approved by a qualified person.

hitch, choker: a method of rigging a sling in which the sling is passed around the load, then through one loop eye, end fitting, or other device with the other loop eye or end fitting attached to the lifting device.

in-line loading: condition where the load is applied through the centerline of the rigging hardware at the intended bearing points.

jaw: a U-shaped load bearing connection, designed for use with a removable pin (see Fig. 5).

line pull: the tension load in a rope entering a rigging block (see Fig. 17).

live end: the section of wire rope that is tensioned under load. (see Figs. 10 and 11).

manufacturer: The entity responsible for the physical production of an item.

pin, shackle: a steel bolt made to span the two shackle ears (see Fig. 3).

primary load fitting: the fitting on a rigging block that carries the highest applied load during use (see Fig. 17).

proof load: the specific load applied in performance of the proof tests.

proof test: a nondestructive load test made to a specific multiple of the rated load of the rigging hardware.

qualified person: a person who, by possession of a recognized degree in an applicable field or certificate of professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

rated capacity: refer to rated load.

rated load: the maximum allowable working load established by the rigging hardware manufacturer. The terms "rated capacity" and "working load limit" are commonly used to describe rated load.

saddle: the base of a wire rope clip (see Fig. 10).

shackle: a U-shaped load-bearing connector designed to be used with a removable pin (see Fig. 1).

shock load: any condition which causes a momentary increase in the forces in a load-supporting component beyond the weight of the actual load being lifted.

sling: an assembly used for lifting when connected to a lifting mechanism. The upper portion is connected to the lifting mechanism and the lower supports the load, as described in the chapters of this Volume.

swivel hoist ring: a load-supporting device capable of pivoting and rotating, consisting of four components: a bolt, a swivel bearing, a bushing flange, and a load connection fitting such as a bail or eye (see Fig. 8).

turnbuckle: an adjustable device consisting of three primary components: a body, a right-hand threaded end fitting, and a left-hand threaded end fitting (see Fig. 5).

wedge socket: an end fitting that terminates a wire rope by compressing the wire rope between a wedge and socket body (see Fig. 11).

wire rope clip: a fitting for clamping two parts of wire rope of the same diameter to each other by compressing the wire ropes between a saddle and a U-bolt or between two saddles (see Fig. 10).

u-bolt type: wire rope clip using one saddle and a U-bolt.

double saddle type: wire rope clip using two saddles.

working load limit (WLL): see *rated load*.

CHAPTER 26-1
Shackles—Selection, Use, and Maintenance

SECTION 26-1.0: SCOPE

This Chapter applies to shackles.

SECTION 26-1.1: TYPES AND MATERIALS

26-1.1.1 Types

(*a*) Body types covered are anchor, chain, and synthetic sling (see Fig. 1).

(*b*) Pin types covered are screw pin and bolt-type (see Fig. 1).

(*c*) Shackles other than those detailed in this chapter shall be used only in accordance with recommendations of the shackle manufacturer or a qualified person.

NOTE: Round pin shackles are not covered by the scope of this volume, because they have limited application in lifting. They are only restrained by a cotter pin and may present a hazard in odd angle loading conditions.

26-1.1.2 Materials

The shackle shall have sufficient ductility to permanently deform before losing the ability to support the load at the temperatures at which the manufacturer has specified for use.

SECTION 26-1.2: DESIGN FACTOR

(*a*) The design factor for shackles up to and including a 150 ton rated load shall be a minimum of 5.

(*b*) The design factor for shackles over 150 ton rated load shall be a minimum of 4.

SECTION 26-1.3: RATED LOADS

Rated load shall be in accordance with the recommendation of the shackle manufacturer. The terms "rated capacity" and "working load limit" are commonly used to describe rated load.

SECTION 26-1.4: PROOF TEST

26-1.4.1 Proof Test Requirements

(*a*) Shackles are not required to be proof tested unless specified by the purchaser.

(*b*) If proof tested, a shackle shall be inspected after the test for the conditions stated in para. 26-1.8.4.

26-1.4.2 Proof Load Requirements

(*a*) The proof load for a shackle up to and including a 150 ton rated load shall be a minimum of 2 and a max-

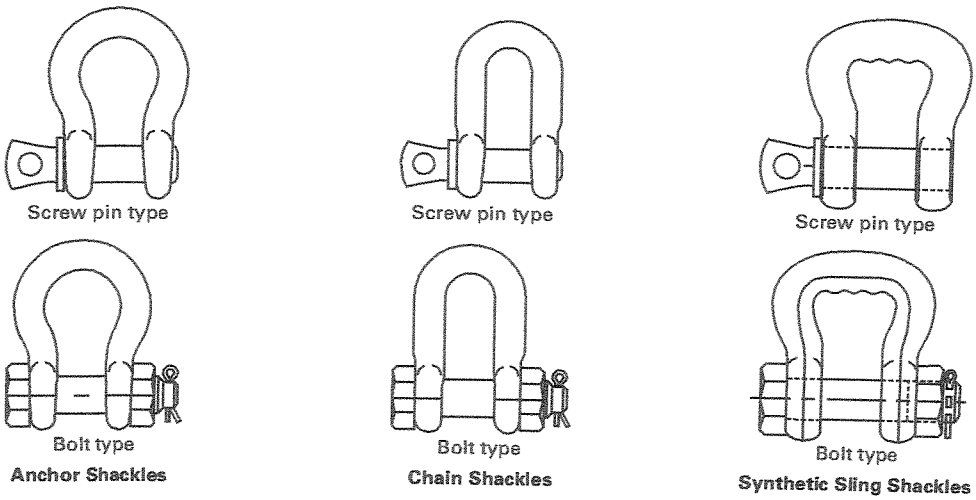


Fig. 1 Shackle Types

imum of 2.2 times the rated load unless approved by the manufacturer.

(*b*) The proof load for a shackle over a 150 ton rated load shall be a minimum of 1.33 and a maximum of 2 times the rated load unless approved by the manufacturer.

SECTION 26-1.5: IDENTIFICATION

26-1.5.1 Shackle Body Identification

Each new shackle body shall have forged, cast, or die stamped markings by the manufacturer to show

(*a*) name or trademark of manufacturer
(*b*) rated load
(*c*) size

26-1.5.2 Shackle Pin Identification

Each new shackle pin shall have forged, cast, or die-stamped markings by the manufacturer to show

(*a*) name or trademark of manufacturer
(*b*) grade, material type, or load rating

26-1.5.3 Maintenance of Identification

Shackle identification should be maintained by the user so as to be legible throughout the life of the shackle.

SECTION 26-1.6: EFFECTS OF ENVIRONMENT

26-1.6.1 Temperature

When shackles are to be used at temperatures above 400°F (204°C) or below −40°F (−40°C), the shackle manufacturer or a qualified person should be consulted.

26-1.6.2 Chemically Active Environments

The strength of shackles can be affected by chemically active environments such as caustic or acid substances or fumes. The shackle manufacturer or a qualified person should be consulted before shackles are used in chemically active environments.

SECTION 26-1.7: TRAINING

Shackle users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

SECTION 26-1.8: INSPECTION, REPAIR, AND REMOVAL

26-1.8.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired shackles shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter. Written records are not required.

26-1.8.2 Frequent Inspection

(*a*) A visual inspection shall be performed by the user or other designated person each day before the shackle is used. Semi-permanent and inaccessible locations where frequent inspections are not feasible shall have periodic inspections performed.

(*b*) Conditions such as those listed in para. 26-1.8.4 or any other condition that may result in a hazard shall cause the shackle to be removed from service. Shackles shall not be returned to service until approved by a qualified person.

(*c*) Written records are not required.

26-1.8.3 Periodic Inspection

(*a*) A complete inspection of the shackle shall be performed by a designated person. The shackle shall be examined for conditions such as those listed in Section 26-1.8.4 and a determination made as to whether they constitute a hazard.

(*b*) *Periodic Inspection Frequency.* Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on

(*1*) frequency of shackle use
(*2*) severity of service conditions
(*3*) nature of lifts being made
(*4*) experience gained on the service life of shackles used in similar circumstances
(*5*) Guidelines for the time intervals are
(*a*) normal service – yearly
(*b*) severe service – monthly to quarterly
(*c*) special service – as recommended by a qualified person

(*c*) Written records are not required.

26-1.8.4 Removal Criteria

Shackles shall be removed from service if damage such as the following is visible and shall only be returned to service when approved by a qualified person:

(*a*) missing or illegible manufacturer's name or trademark and/or rated load identification
(*b*) indications of heat damage including weld spatter or arc strikes
(*c*) excessive pitting or corrosion
(*d*) bent, twisted, distorted, stretched, elongated, cracked, or broken load-bearing components
(*e*) excessive nicks or gouges
(*f*) a 10% reduction of the original or catalog dimension at any point around the body or pin
(*g*) incomplete pin engagement
(*h*) excessive thread damage
(*i*) evidence of unauthorized welding

(*j*) other conditions, including visible damage, that cause doubt as to the continued use of the shackle

26-1.8.5 Repairs and Modifications

(*a*) Repairs, alterations, or modifications shall be as specified by the shackle manufacturer or a qualified person.

(*b*) Replacement parts, such as pins, shall meet or exceed the original equipment manufacturer's specifications.

SECTION 26-1.9: OPERATING PRACTICES

26-1.9.1 Shackle Selection

(*a*) Shackles having suitable characteristics for the type of sling, load, hitch, and environment shall be selected in accordance with the shackle manufacturer's data.

NOTE: The angle of loading affects the stress in the shackle. As the horizontal angle decreases, the stress increases in the shackle (see Fig. 2).

(*b*) The rated load of the shackle shall not be exceeded.

(*c*) Shackles that appear to be damaged shall not be used until inspected and accepted as usable under Section 26-1.8.

26-1.9.2 Cautions to Personnel

(*a*) All portions of the human body shall be kept from between the shackle, the load, and any other rigging during the lift.

(*b*) Personnel should stand clear of the suspended load.

(*c*) Personnel shall not ride the shackle.

26-1.9.3 Storage & Work Environments

(*a*) Shackles should be stored in an area where they will not be subjected to damage, corrosive action, or extreme heat.

(*b*) If extreme temperatures or chemically active environments are involved, the guidance provided in paras. 26-1.6.1 or 26-1.6.2 shall be followed.

26-1.9.4 Rigging Practices

(*a*) The screw pin shall be fully engaged, with the shoulder in contact with the shackle body (see Fig. 3).

(*b*) If a shackle is designed for a cotter pin, it shall be used and maintained in good working condition. Alterations or modifications shall comply with para. 26-1.8.5(a).

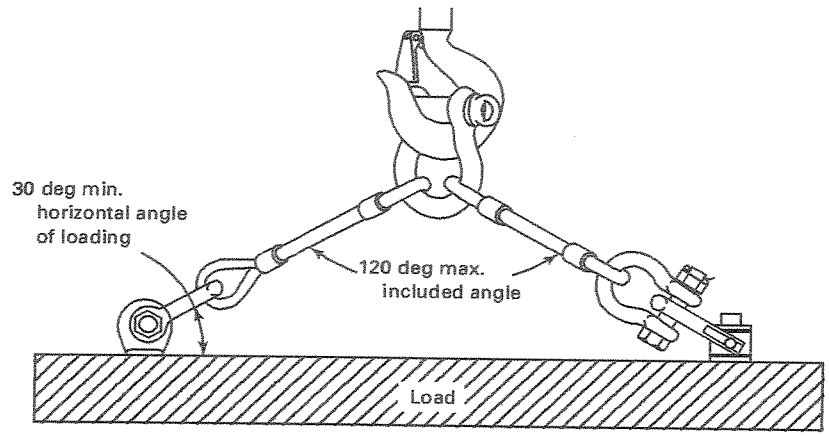
(*c*) Contact with sharp edges that could damage the shackle should be avoided.

(*d*) Shock loading should be avoided.

(*e*) The load applied to the shackle should be centered in the bow of the shackle to prevent side loading of the shackle.

(*f*) Multiple sling legs should not be applied to the shackle pin.

(*g*) If the shackle is to be side loaded, the rated load shall be reduced according to the recommendations of the manufacturer or a qualified person (see Fig. 4).



Horizontal Angle, deg	Stress Multiplier
90	1.000
60	1.155
45	1.414
30	2.000

Fig. 2 Angle of Loading (Shackles)

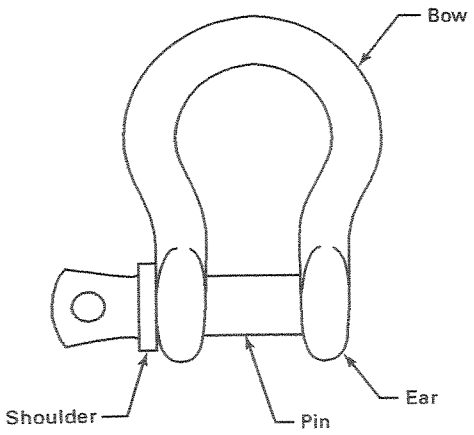


Fig. 3 Typical Shackle Components

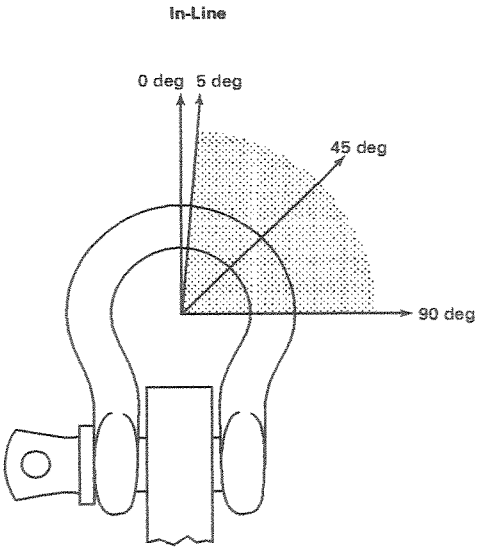
(*h*) The screw pin shackle shall not be rigged in a manner that would cause the pin to unscrew.

(*i*) For long-term installations, bolt type shackles should be used; if screw pin type shackles are used, the pin shall be secured from rotation or loosening.

(*j*) Shackles should not be dragged on an abrasive surface.

(*k*) Multiple slings in the body of a shackle shall not exceed 120 deg included angle.

(*l*) When a shackle is used in a choker hitch, the pin shall be connected to the choking eye of the sling.



Side Loading Angle, deg	% Rate Load Reduction
In-line (0) to 5	None
6 to 45	30%
46 to 90	50%
Over 90	Not recommended to load in this condition. Consult manufacturer or qualified person.

Fig. 4 Side Loading

Chapter 26-2
Adjustable Hardware — Selection, Use, and Maintenance

SECTION 26-2.0: SCOPE

This Chapter applies to adjustable hardware including turnbuckles, eyebolts, eye nuts, and swivel hoist rings.

SECTION 26-2.1: TYPES AND MATERIALS

26-2.1.1 Types

(*a*) Turnbuckles, including open and pipe body types with hook, eye, or jaw end fittings (see Fig. 5).

(*b*) Eyebolts including shoulder nut, nonshoulder nut, nonshoulder machinery, and shoulder machinery types (see Fig. 6).

(*c*) Eye nuts (see Fig. 7).

(*d*) Swivel hoist rings (see Fig. 8).

(*e*) Adjustable hardware other than those detailed in this chapter shall be used only in accordance with recommendations of the manufacturer or a qualified person.

26-2.1.2 Materials

The hardware, excluding bushings and bearings, shall have sufficient ductility to permanently deform before losing the ability to support the load at the temperatures at which the manufacturer has specified for use.

SECTION 26-2.2: DESIGN FACTOR

The design factor for adjustable hardware shall be a minimum of 5.

SECTION 26-2.3: RATED LOADS

Rated load shall be in accordance with the recommendation of the hardware manufacturer. The terms "rated capacity" and "working load limit" are commonly used to describe rated load.

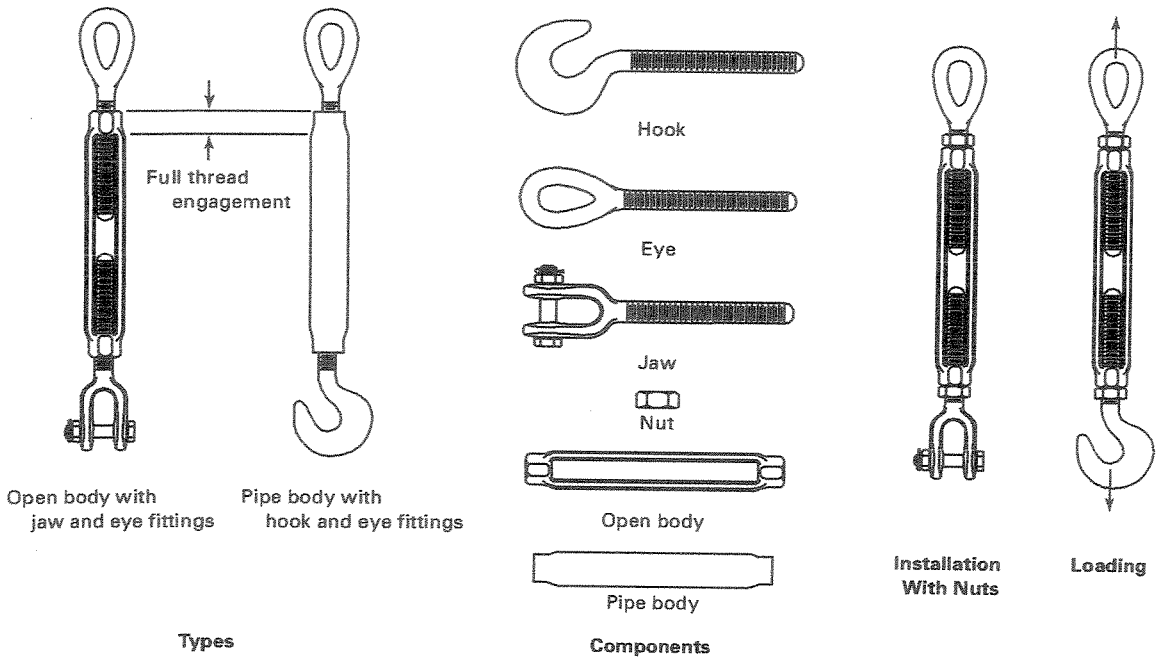


Fig. 5 Turnbuckles

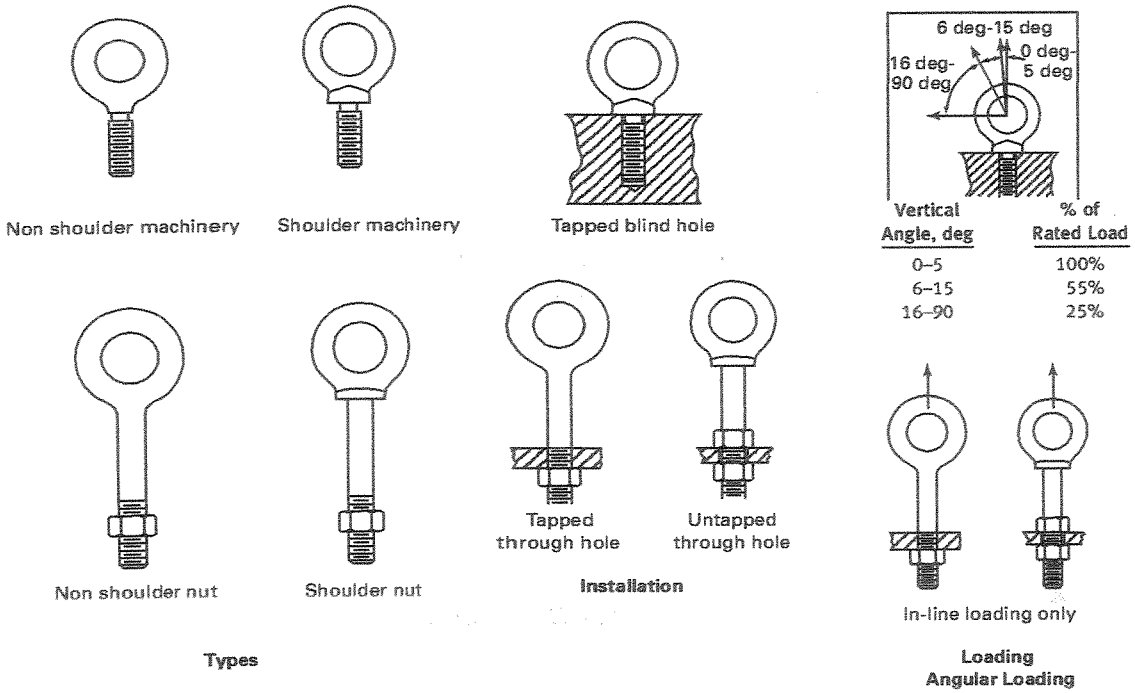


Fig. 6 Eyebolts

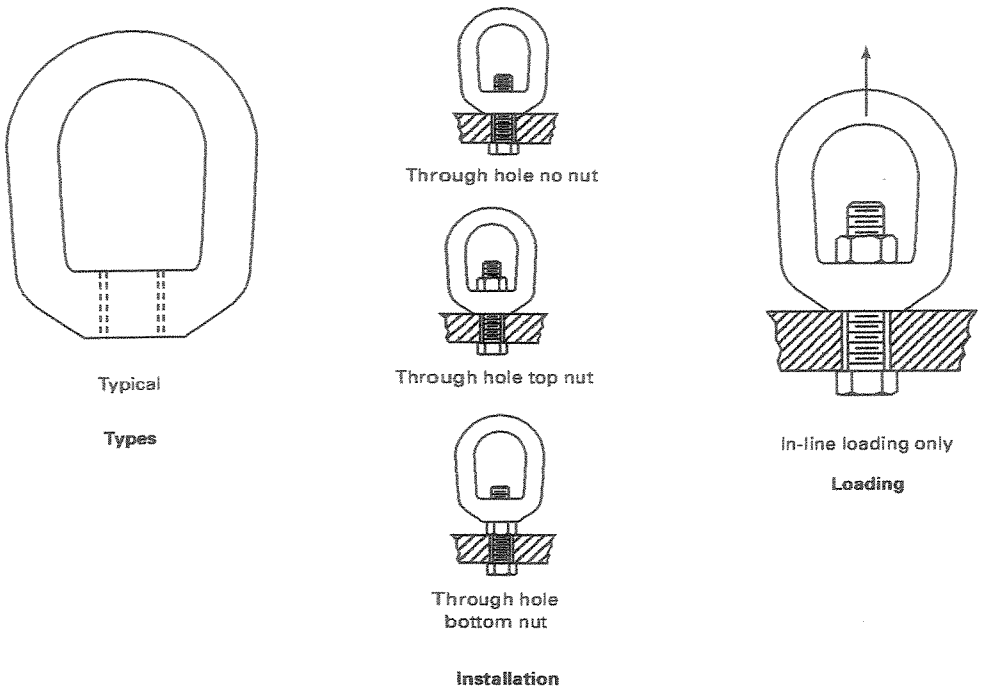


Fig. 7 Eye Nuts

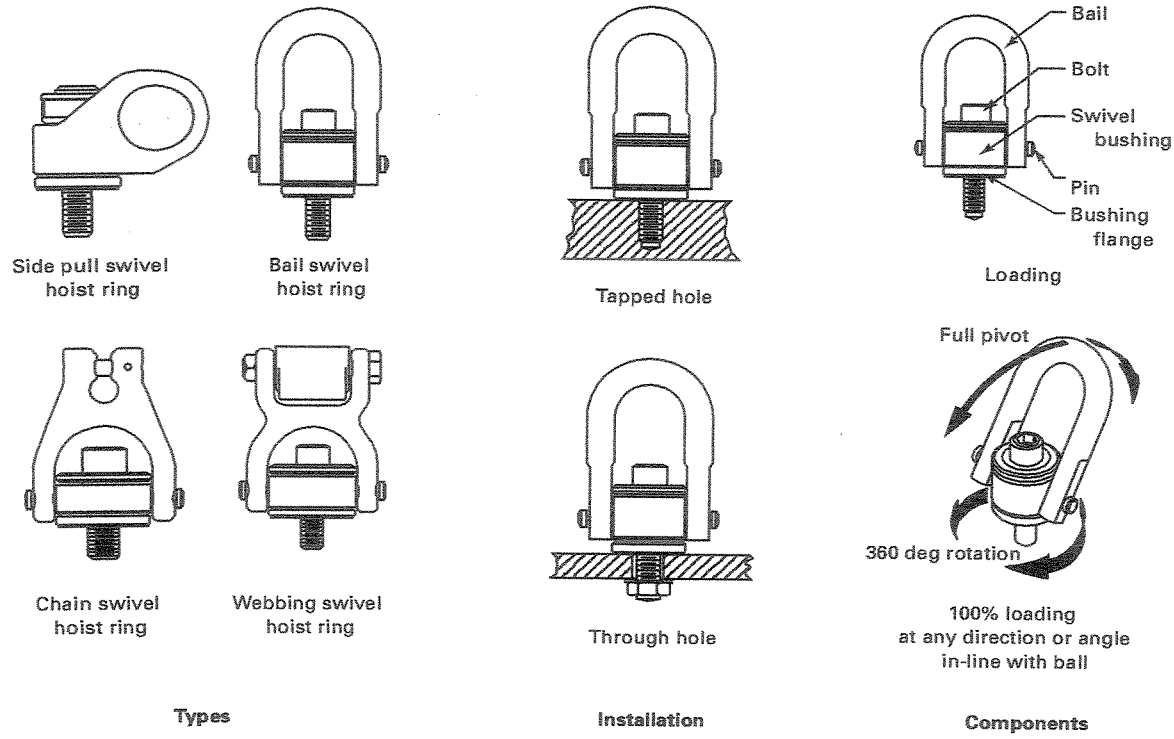


Fig. 8 Swivel Hoist Rings

SECTION 26-2.4: PROOF TEST

26-2.4.1 Proof Test Requirements

(*a*) New adjustable hardware is not required to be proof tested unless specified by the purchaser.

(*b*) All repairs to swivel hoist rings with bushings or bearings should be proof tested.

(*c*) If proof tested, adjustable hardware shall be inspected after the test for the conditions stated in para. 26-2.8.4.

26-2.4.2 Proof Load Requirements

The proof load shall be a minimum of 2 times the rated load.

SECTION 26-2.5: IDENTIFICATION

26-2.5.1 Turnbuckle, Eyebolt, and Eye Nut Identification

Each turnbuckle, eyebolt, and eye nut shall be marked to show

(*a*) name or trademark of manufacturer
(*b*) size or rated load
(*c*) grade for alloy eyebolts

26-2.5.2 Swivel Hoist Ring Identification

Each swivel hoist ring shall be marked to show

(*a*) name or trademark of manufacturer
(*b*) rated load
(*c*) torque value

26-2.5.3 Adjustable Hardware Identification

Adjustable hardware identification shall be provided by the manufacturer.

26-2.5.4 Maintenance of Identification

Turnbuckle, eyebolt, eye nut, and swivel hoist ring identification should be maintained by the user so as to be legible during the life of the hardware.

SECTION 26-2.6: EFFECTS OF ENVIRONMENT

26-2.6.1 Temperature

(*a*) When adjustable hardware, excluding swivel hoist rings and carbon steel eyebolts, is to be used at temperatures above 400°F (204°C) or below −40°F (−40°C), the hardware manufacturer or a qualified person should be consulted.

(*b*) When swivel hoist rings are to be used at temperatures above 400°F (204°C) or below −20°F (−29°C), the hardware manufacturer or a qualified person should be consulted.

(*c*) When carbon steel eyebolts are to be used at temperatures above 275°F (135°C) or below 30°F (−1°C), the hardware manufacturer or a qualified person should be consulted.

26-2.6.2 Chemically Active Environments

The strength of adjustable hardware can be affected by chemically active environments such as caustic or acid substances or fumes. The adjustable hardware manufacturer or a qualified person should be consulted before use in chemically active environments.

SECTION 26-2.7: TRAINING

Adjustable hardware users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

SECTION 26-2.8: INSPECTION, REPAIR, AND REMOVAL

26-2.8.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired adjustable hardware shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter. Written records are not required.

26-2.8.2 Frequent Inspection

(*a*) A visual inspection shall be performed by the user or other designated person each shift before the adjustable hardware is used. Semi-permanent and inaccessible locations where frequent inspections are not feasible shall have periodic inspections performed.

(*b*) Conditions such as those listed in para. 26-2.8.4 or any other condition that may result in a hazard shall cause the adjustable hardware to be removed from service. Adjustable hardware shall not be returned to service until approved by a qualified person.

(*c*) Written records are not required.

26-2.8.3 Periodic Inspection

(*a*) A complete inspection of the adjustable hardware shall be performed by a designated person. The adjustable hardware shall be examined for conditions such as those listed in para. 26-2.8.4 and a determination made as to whether they constitute a hazard.

(*b*) *Periodic Inspection Frequency.* Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on

(*1*) frequency of use

(*2*) severity of service conditions

(*3*) nature of lifts being made

(*4*) experience gained on the service life of adjustable hardware used in similar circumstances

(*5*) Guidelines for the time intervals are

(*a*) normal service – yearly

(*b*) severe service – monthly to quarterly

(*c*) special service – as recommended by a qualified person

(*c*) Written records are not required.

26-2.8.4 Removal Criteria

Adjustable hardware shall be removed from service if damage such as the following is present and shall only be returned to service when approved by a qualified person:

(*a*) missing or illegible identification

(*b*) indications of heat damage including weld spatter or arc strikes

(*c*) excessive pitting or corrosion

(*d*) bent, twisted, distorted, stretched, elongated, cracked, or broken load-bearing components

(*e*) excessive nicks or gouges

(*f*) a 10% reduction of the original or catalog dimension at any point

(*g*) excessive thread damage or wear

(*h*) evidence of unauthorized welding or modification

(*i*) for swivel hoist rings, lack of the ability to freely rotate or pivot

(*j*) other conditions, including visible damage, that cause doubt as to continued use

26-2.8.5 Repairs and Modifications

(*a*) Repairs, alterations, or modifications shall be as specified by the adjustable hardware manufacturer or a qualified person.

(*b*) Replacement parts, including nuts, pins, and bolts, shall meet or exceed the original equipment manufacturer's specifications.

SECTION 26-2.9: OPERATING PRACTICES

26-2.9.1 Adjustable Hardware Selection

(*a*) Adjustable hardware having suitable characteristics for the type of load, hitch, angle of loading, and environment shall be selected in accordance with the adjustable hardware manufacturer's data.

NOTE 1: The angle of loading affects the stress in the hardware. As the horizontal angle decreases, the stress increases (see Fig. 9).

NOTE 2: The integrity of the load where the adjustable hardware attaches is the responsibility of the end user.

(*b*) The rated load of the adjustable hardware shall not be exceeded.

(*c*) Adjustable hardware that appears to be damaged shall not be used until inspected and accepted as usable per Section 26-2.8.

26-2.9.2 Cautions to Personnel

(*a*) All portions of the human body shall be kept from between the rigging hardware, the load, and any other rigging during the lift.

(*b*) Personnel should stand clear of the suspended load.

(*c*) Personnel shall not ride rigging hardware.

26-2.9.3 Storage & Work Environments

(*a*) Adjustable hardware should be stored in an area where it will not be subjected to damage, corrosive action, or extreme heat.

(*b*) If extreme temperatures or chemically active environments are involved, the guidance provided in paras. 26-2.6.1 or 26-2.6.2 shall be followed.

26-2.9.4 Rigging Practices

26-2.9.4.1 Turnbuckles

(*a*) Turnbuckle end fitting threads shall be fully engaged in the body threads.

NOTE: Pipe bodies conceal the length of thread engagement. Verify full engagement before loading (see Fig. 5).

(*b*) Components, including pins, bolts, nuts, or cotter pins used with jaw ends, shall be in good working condition prior to use. Alterations or modifications shall comply with para. 26-2.8.5(a).

(*c*) If locking nuts (see Fig. 5) are used they shall be compatible with the threads of the turnbuckle end.

(*d*) Contact with obstructions that could damage or bend the turnbuckle should be avoided.

(*e*) Shock loading should be avoided.

(*f*) The load applied to the turnbuckle should be in line and in tension.

(*g*) Turnbuckles should not be side loaded.

(*h*) Turnbuckles should be rigged or secured to prevent unscrewing during the lift.

(*i*) For long-term installations, turnbuckles shall be secured to prevent unscrewing.

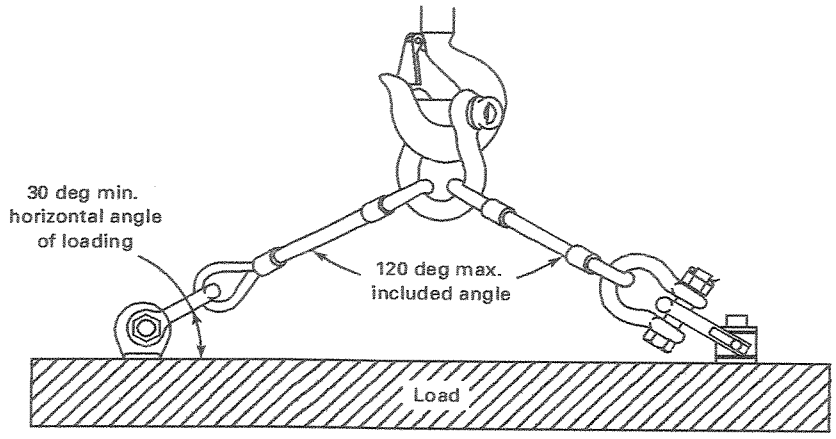
(*j*) Turnbuckles should not be dragged on an abrasive surface.

(*k*) Turnbuckles should be adjusted with a properly sized wrench, used on the wrench flats of the turnbuckle body.

26-2.9.4.2 Eyebolts

(*a*) Eyebolts should be tightened or otherwise secured against rotation during the lift.

(*b*) When used in a tapped blind hole, the effective thread length shall be at least $1\frac{1}{2}$ times the diameter of the bolt for engagement in steel (see Fig. 6). For other thread engagements or engagement in other materials, contact the eyebolt manufacturer or a qualified person.



Horizontal Angle, deg	Stress Multiplier
90	1.000
60	1.155
45	1.414
30	2.000

Fig. 9 Angle of Loading (Adjustable Hardware)

(*c*) When used in a tapped through-hole of less than one diameter thickness, a nut shall be used under the load and shall be fully engaged and tightened securely against the load (see Fig. 6).

(*d*) When used in an untapped through-hole the nut under the load shall be fully engaged. If the eyebolt is not shouldered to the load, a second nut on top of the load should be used where possible (see Fig. 6).

(*e*) Eyebolts not shouldered to the load shall only be used for in-line loads (see Fig. 6).

(*f*) Only shoulder eyebolts shall be used for angular lifting. When used for angular lifting, the shoulder shall be flush and securely tightened against the load. The working load limit (WLL) must be reduced as shown in Fig. 6.

(*g*) When using shoulder eyebolts for angular lifts, the plane of the eye shall be aligned with the direction of loading. Flat washers may be used under the shoulder to position the plane of the eye (see Fig. 6).

(*h*) Eyebolts shall be in good working condition prior to use. Alterations or modifications shall comply with para. 26-2.8.5(a).

(*i*) Shock loading should be avoided.

26-2.9.4.3 Eye Nuts

(*a*) Eye nuts should be secured against rotation during the lift.

(*b*) The threads of the eye nut shall be fully engaged (see Fig. 7).

(*c*) Eye nuts shall only be used for in-line loads (see Fig. 7).

(*d*) The plane of the eye may be positioned with a flat washer(s) or lock nut.

(*e*) Components shall be in good working condition prior to use. Alterations or modifications shall comply with para. 26-2.8.5(a).

(*f*) Shock loading should be avoided.

26-2.9.4.4 Swivel Hoist Rings

(*a*) When used in a threaded-hole, the effective thread length shall be $1^1/_2$ times the diameter of the bolt for steel (see Fig. 8). For other thread engagements or engagement in other materials, contact the swivel hoist ring manufacturer or a qualified person.

(*b*) When used in a through-hole application, a nut and washer shall be used. The washer and nut shall be in accordance with the swivel hoist ring manufacturer's recommendations. The nut shall be fully engaged (see Fig. 8).

(*c*) The bushing flange (see Fig. 8) shall fully contact the load surface.

(*d*) Spacers or washers shall not be used between the bushing flange and the mounting surface of the load being lifted.

(*e*) The swivel hoist ring shall be tightened to the torque specifications of the manufacturer.

(*f*) The swivel hoist ring shall be free to rotate and pivot without interference during lifting (see Fig. 8).

(*g*) The load applied to the swivel hoist ring shall be centered in the bail to prevent side loading.

(*h*) Any attached lifting component shall be narrower than the inside width of the bail to avoid spreading (see Fig. 8).

(*i*) Components shall be in good working condition prior to use. Alterations or modifications shall comply with para. 26-2.8.5(a).

(*j*) Ensure that the swivel hoist ring WLL meets or exceeds the anticipated angular rigging tension (see Fig. 9).

(*k*) Shock loading should be avoided.

Chapter 26-3
Compression Hardware – Selection, Use, and Maintenance

SECTION 26-3.0: SCOPE

This Chapter applies to compression hardware including forged wire rope clips and wedge sockets.

SECTION 26-3.1: TYPES, MATERIALS, AND ASSEMBLY

26-3.1.1 Types

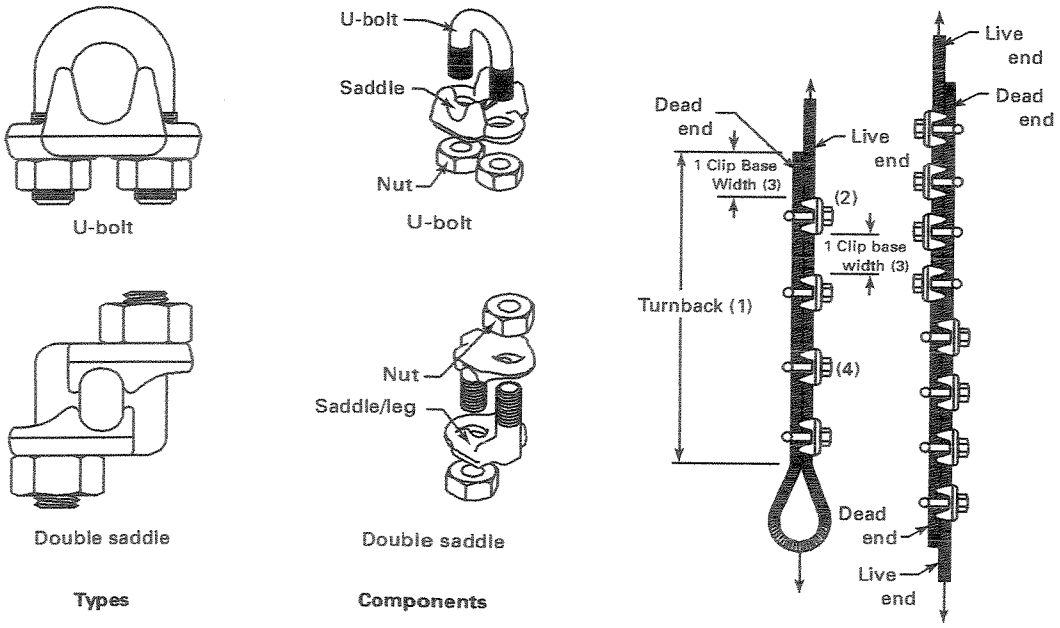
(*a*) Wire rope clip types covered are U-bolt and double saddle (see Fig. 10).

(*b*) Wedge sockets (see Fig. 11).

(*c*) Compression hardware other than those detailed in this chapter shall be used only in accordance with recommendations of the manufacturer or a qualified person.

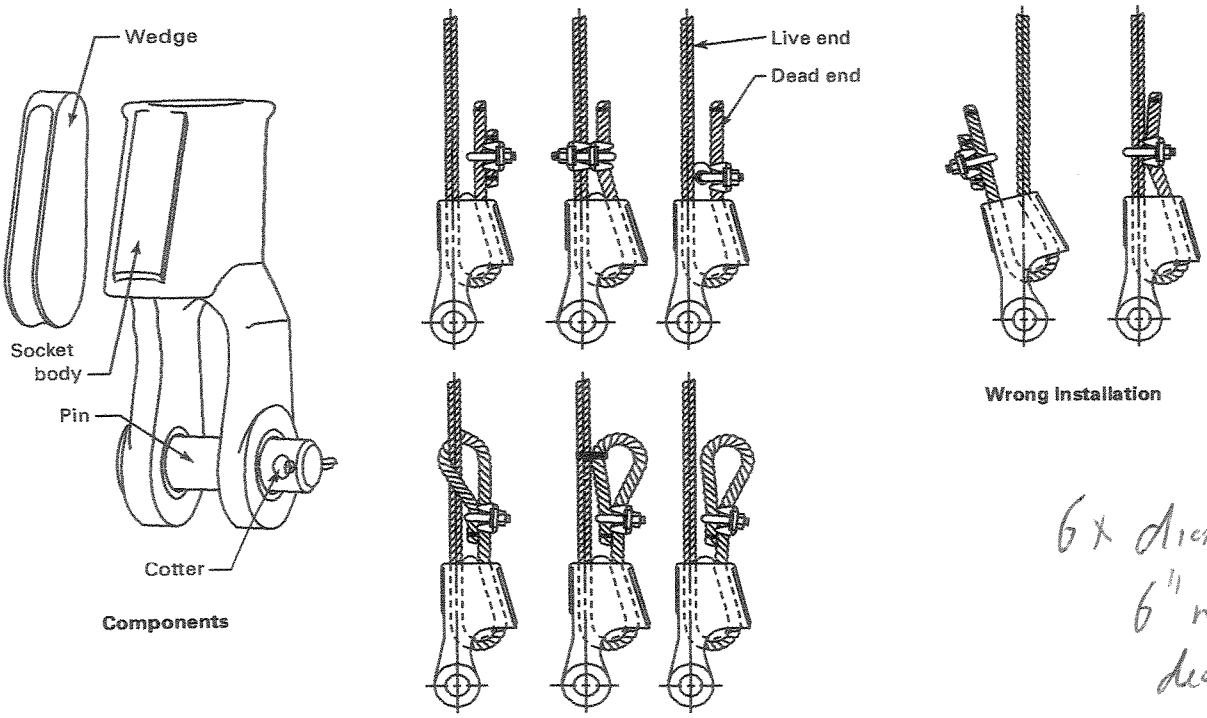
26-3.1.2 Materials

(*a*) Wire rope clip materials shall be of sufficient strength such that failure of the wire rope will occur before failure of the wire rope clip at the temperatures



GENERAL NOTE: Correct number of clips for wire rope size shall be used.
NOTES:
(1) correct turnback length should be used
(2) correct orientation of saddle on live end shall be observed
(3) correct spacing of clips should be used
(4) correct torque on nuts shall be applied

Fig. 10 Wire Rope Clips



6 x dia or 6" min. dead end.

Fig. 11 Wedge Sockets

that the manufacturer has specified for use. Saddles shall be forged steel.

(*b*) Wedge socket materials shall be of sufficient strength such that failure of the wire rope will occur before failure of the wedge socket at the temperatures, that the manufacturer has specified for use.

26-3.1.3 Assembly – Wire Rope Clips

(*a*) Before installing a wire rope clip on plastic coated or plastic impregnated wire rope, consult the wire rope clip manufacturer, wire rope manufacturer, or a qualified person.

(*b*) For U-bolt clips used to create end terminations, the saddle shall be placed on the live end of the wire rope, with the U-bolt on the dead end side (see Fig. 10).

(*c*) At least the minimum number of clips as recommended by the manufacturer or a qualified person shall be used.

(*d*) The spacing and turn-back should be as recommended by the manufacturer or a qualified person.

(*e*) The wire rope clip shall be tightened to the torque recommended by the manufacturer or a qualified person.

(*f*) After assembly, the connection shall be loaded to at least the expected working load. After unloading, wire rope clips shall then be re-tightened to the torque recommended by the manufacturer or a qualified person.

26-3.1.4 Assembly – Wedge Sockets

(*a*) The wedge socket shall be assembled as recommended by the manufacturer or a qualified person.

(*b*) Before installing a wedge socket on plastic coated or plastic impregnated wire rope, consult the wedge socket manufacturer, wire rope manufacturer, or a qualified person.

(*c*) The live end of the wire rope in the wedge socket cavity shall be in alignment with the socket's pin (see Fig. 11).

(*d*) The assembler shall match the proper wedge with the socket for the wire rope to be installed.

NOTE: Wedges shall not be interchanged between different manufacturers' sockets or models.

(*e*) The length of the dead end tail of the wire rope shall be as required by the manufacturer or a qualified person.

(*f*) The dead end tail of the wire rope extending beyond the wedge socket shall be secured in a manner rec-

ommended by the wedge socket manufacturer or a qualified person (see Fig. 11).

(*g*) The dead end of the wire rope shall not be secured to the live end of the wire rope such that it restricts the movement of the live end (see Fig. 11).

(*h*) After assembly, the connection shall be loaded to fully seat the wedge before use.

SECTION 26-3.2: DESIGN FACTOR

Due to the nature of the design and use, wire rope clips and wedge sockets do not have a conventional design factor. Wire rope clips and wedge sockets shall be designed to have an 80% minimum connection efficiency based on the wire rope published minimum breaking force with which they are used.

SECTION 26-3.3: RATED LOADS

The rated load for wire rope assemblies using compression hardware is based on the following factors:

(*a*) wire rope minimum breaking force
(*b*) 80% minimum connection efficiency
(*c*) design factor of the wire rope application

SECTION 26-3.4: PROOF TEST

26-3.4.1 Proof Test Requirements

(*a*) Compression hardware is not required to be proof tested unless specified by the purchaser.

(*b*) If required, the proof test shall be applied to the wedge socket or the connection made by the wire rope clips after the assembly is complete.

(*c*) After proof testing, wire rope clips on a finished assembly shall be re-tightened to the torque recommended by the wire rope clip manufacturer or a qualified person.

(*d*) If proof tested, compression hardware shall be inspected after the test for the conditions stated in para. 26-3.8.4.

26-3.4.2 Proof Load Requirements

The proof load shall be a minimum of 40%, but not exceed 50%, of the wire rope minimum breaking force unless approved by the compression hardware manufacturer or a qualified person.

SECTION 26-3.5: IDENTIFICATION

26-3.5.1 Wire Rope Clip Saddle Identification

Each new wire rope clip saddle shall have forged or die stamped markings by the manufacturer to show

(*a*) name or trademark of manufacturer
(*b*) size

26-3.5.2 Wedge Socket Identification

Each new wedge socket body and wedge shall have forged, cast, or die stamped marking by the manufacturer to show

(*a*) name or trademark of manufacturer
(*b*) size
(*c*) model, if required to match wedge to body

26-3.5.3 Maintenance of Identification

Compression hardware identification should be maintained by the user so as to be legible throughout the life of the hardware.

SECTION 26-3.6: EFFECTS OF ENVIRONMENT

26-3.6.1 Temperature

(*a*) When wire rope clips are to be used at temperatures above 400°F (204°C) or below −40°F (−40°C), the wire rope clip manufacturer or a qualified person should be consulted.

(*b*) When wedge sockets are to be used at temperatures above 400°F (204°C) or below −4°F (−20°C), the wedge socket manufacturer or a qualified person should be consulted.

26-3.6.2 Chemically Active Environments

The strength of compression hardware can be affected by chemically active environments such as caustic or acid substances or fumes. The compression hardware manufacturer or a qualified person should be consulted before compression hardware is used in chemically active environments.

SECTION 26-3.7: TRAINING

Compression hardware users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

SECTION 26-3.8: INSPECTION, REPAIR, AND REMOVAL

26-3.8.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired compression hardware shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter. Written records are not required.

26-3.8.2 Frequent Inspection

(*a*) A visual inspection shall be performed by the user or other designated person each day before the compression hardware is used. Semi-permanent and inaccessible locations where frequent inspections are not feasible shall have periodic inspections performed.

(*b*) Conditions such as those listed in para. 26-3.8.4, or any other condition that may result in a hazard, shall cause the compression hardware to be removed from service. Compression hardware shall not be returned to service until approved by a qualified person.

(*c*) Written records are not required.

26-3.8.3 Periodic Inspection

(*a*) A complete inspection of the compression hardware shall be performed by a designated person. The compression hardware shall be examined for conditions such as those listed in para. 26-3.8.4 and a determination made as to whether they constitute a hazard.

(*b*) *Periodic Inspection Frequency.* Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on

(*1*) frequency of compression hardware use

(*2*) severity of service conditions

(*3*) nature of lifts being made

(*4*) experience gained on the service life of compression hardware used in similar circumstances

(*5*) Guidelines for the time intervals are

(*a*) normal service – yearly

(*b*) severe service – monthly to quarterly

(*c*) special service – as recommended by a qualified person

(*c*) Written records are not required.

26-3.8.4 Removal Criteria

Compression hardware shall be removed from service if conditions such as the following are visible and shall only be returned to service when approved by a qualified person:

(*a*) missing or illegible identification

(*b*) indications of heat damage including weld spatter or arc strikes

(*c*) excessive pitting or corrosion

(*d*) bent, twisted, distorted, stretched, elongated, cracked, or broken components

(*e*) excessive nicks or gouges

(*f*) a 10% reduction of the original or catalog dimension at any point

(*g*) evidence of unauthorized welding

(*h*) unauthorized replacement components

(*i*) insufficient number of wire rope clips

(*j*) improperly tightened wire rope clips

(*k*) indications of damaged wire rope

(*l*) indications of wire rope slippage

(*m*) improper assembly or other conditions, including visible damage, that cause doubt as to continued use

26-3.8.5 Repairs and Modifications

(*a*) Repairs, alterations, or modifications shall be as specified by the compression hardware manufacturer or a qualified person.

(*b*) Replacement parts shall meet or exceed the original compression hardware manufacturer's specifications.

SECTION 26-3.9: OPERATING PRACTICES

26-3.9.1 Compression Hardware Selection

(*a*) Compression hardware having suitable characteristics for the type of application and environment shall be selected in accordance with the recommendations of the compression hardware manufacturer or a qualified person.

(*b*) The rated load shall not be exceeded (see Section 26-3.3).

(*c*) Compression hardware that appears to be damaged shall not be used until inspected and accepted as usable under Section 26-3.8.

26-3.9.2 Cautions to Personnel

(*a*) All portions of the human body shall be kept from between the load and any other rigging during the lift.

(*b*) Personnel should stand clear of the suspended load.

(*c*) Personnel shall not ride rigging hardware.

26-3.9.3 Storage & Work Environments

(*a*) Compression hardware should be stored in an area where it will not be subjected to damage, corrosive action, or extreme heat.

(*b*) If extreme temperatures or chemically active environments are involved, the guidance provided in paras. 26-3.6.1 or 26-3.6.2 shall be followed.

26-3.9.4 Rigging Practices

26-3.9.4.1 Wire Rope Clips

(*a*) Assemble wire rope clips in accordance with para. 26-3.1.3.

(*b*) Wire rope clips should not be in contact with the load or any obstruction during the lift.

(*c*) Shock loading should be avoided.

(*d*) Rigging using wire rope clips should not be dragged on an abrasive surface.

(*e*) When wire rope clips are applied to join two lengths of wire rope in an in-line splice, the requirements of para. 26-3.1.3 shall be followed (see Fig. 10).

(*f*) The use of wire rope clips to fabricate slings is generally prohibited. See ASME B30.9 for specific exceptions.

26-3.9.4.2 Wedge Sockets

(*a*) Assemble wedge sockets in accordance with para. 26-3.1.4.

(*b*) The wedge sockets should not be side loaded.

(*c*) Contact with sharp edges that could damage the wedge socket should be avoided.

(*d*) Shock loading should be avoided.

(*e*) Impacts can dislodge the wedge from the body and should be avoided.

(*f*) Rigging using wedge sockets should not be dragged on an abrasive surface.

Chapter 26-4
Links, Rings, and Swivels – Selection, Use, and Maintenance

SECTION 26-4.0: SCOPE

This Chapter applies to links, rings, and swivels.

SECTION 26-4.1: TYPES AND MATERIALS

26-4.1.1 Types

(*a*) Links and rings, including oblong, round and pear shapes (see Fig. 12).

(*b*) Swivels, including eye & eye and eye & jaw types used for positioning (see Fig. 13).

(*c*) Links, rings, and swivels other than those detailed in this Chapter shall be used only in accordance with recommendations of the manufacturer or a qualified person.

26-4.1.2 Materials

Links, rings, and swivels shall have sufficient ductility to permanently deform before losing the ability to support the load at the temperatures that the manufacturer has specified for use.

SECTION 26-4.2: DESIGN FACTOR

The design factor for links, rings, and swivels shall be a minimum of 5.

SECTION 26-4.3: RATED LOADS

Rated load shall be in accordance with the recommendation of the link, ring, or swivel manufacturer. The terms "rated capacity" and "working load limit" are commonly used to describe rated load.

SECTION 26-4.4: PROOF TEST

26-4.4.1 Proof Test Requirements

(*a*) Prior to initial use, welded links and rings shall be proof tested by the manufacturer or a qualified person.

(*b*) All other links, rings, and swivels are not required to be proof tested unless specified by the purchaser.

(*c*) If proof tested, links, rings, and swivels shall be inspected after the test for the conditions stated in para. 26-4.8.4.

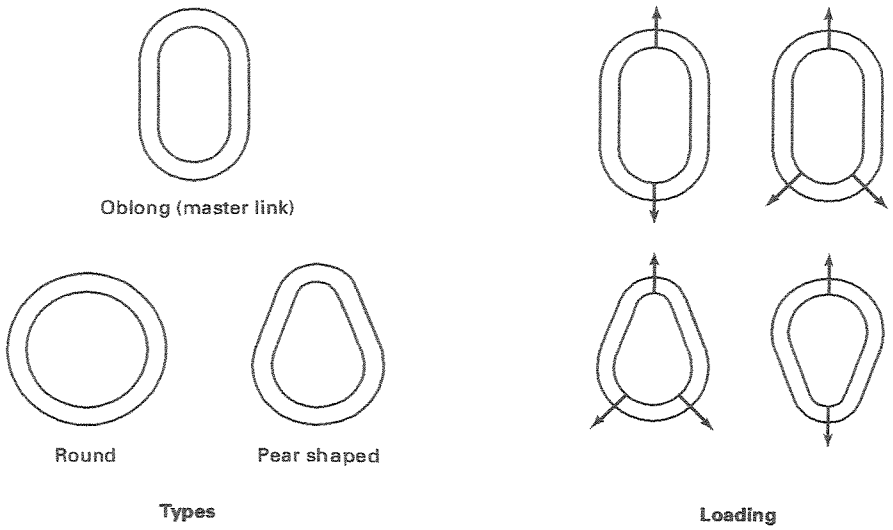


Fig. 12 Links and Rings

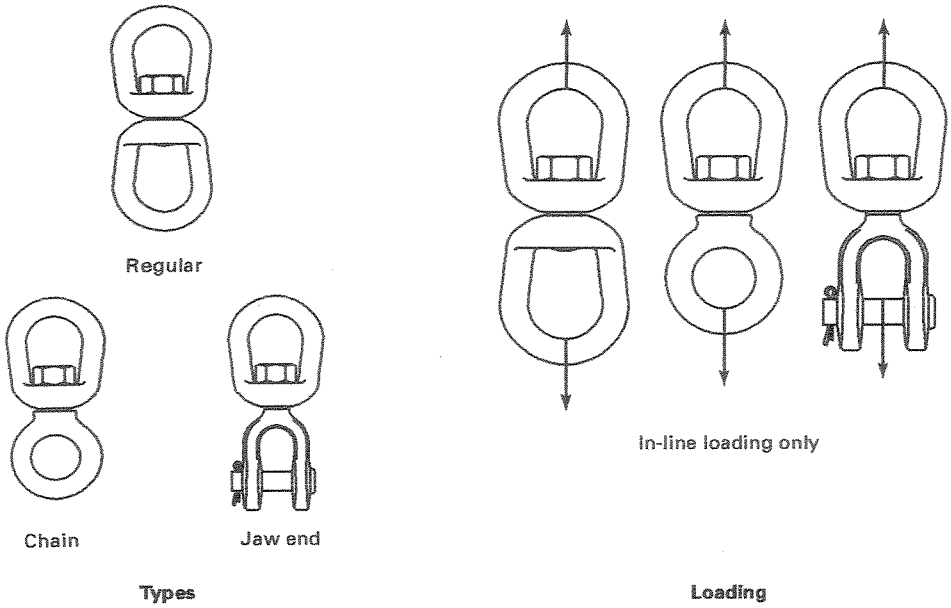


Fig. 13 Swivels

26-4.4.2 Proof Load Requirements

The proof load shall be a minimum of 2 times the rated load.

SECTION 26-4.5: IDENTIFICATION

26-4.5.1 Links, Rings, and Swivels Identification

Each new link, ring, and swivel shall be marked by the manufacturer to show

(*a*) name or trademark of manufacturer
(*b*) size or rated load
(*c*) grade, if required to identify rated load

26-4.5.2 Maintenance of Identification

Link, ring, and swivel identification should be maintained by the user so as to be legible during the life of the hardware.

SECTION 26-4.6: EFFECTS OF ENVIRONMENT

26-4.6.1 Temperature

(*a*) When steel links, rings, or swivels are to be used at temperatures above 400°F (204°C) or below −40°F (−40°C), the link, ring, and swivel manufacturer or a qualified person should be consulted.

(*b*) For links, rings, or swivels made from other materials, consult the manufacturer or a qualified person.

26-4.6.2 Chemically Active Environments

The strength of links, rings, and swivels can be affected by chemically active environments such as caustic or acid substances or fumes. The link, ring, or swivel manufacturer or a qualified person shall be consulted before use in chemically active environments.

SECTION 26-4.7: TRAINING

Link, ring, and swivel users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

SECTION 26-4.8: INSPECTION, REPAIR, AND REMOVAL

26-4.8.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired links, rings, and swivels shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter. Written records are not required.

26-4.8.2 Frequent Inspection

(*a*) A visual inspection shall be performed by the user or other designated person each shift before the links, rings, and swivels are used. Semi-permanent and inaccessible locations where frequent inspections are not feasible shall have periodic inspections performed.

(*b*) Conditions such as those listed in para. 26-4.8.4, or any other condition that may result in a hazard, shall cause the hardware to be removed from service. Links, rings, and swivels shall not be returned to service until approved by a qualified person.

(*c*) Written records are not required.

26-4.8.3 Periodic Inspection

(*a*) A complete inspection of the links, rings, and swivels shall be performed by a designated person. The hardware shall be examined for conditions such as those listed in para. 26-4.8.4 and a determination made as to whether they constitute a hazard.

(*b*) *Periodic Inspection Frequency.* Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on

(1) frequency of use

(2) severity of service conditions

(3) nature of lifts being made

(4) experience gained on the service life of hardware used in similar circumstances

(5) Guidelines for the time intervals are

(*a*) normal service – yearly

(*b*) severe service – monthly to quarterly

(*c*) special service – as recommended by a qualified person

(*c*) Written records are not required.

26-4.8.4 Removal Criteria

Links, rings, and swivels shall be removed from service if conditions such as the following are present and shall only be returned to service when approved by a qualified person:

(*a*) missing or illegible identification

(*b*) indications of heat damage, including weld spatter or arc strikes

(*c*) excessive pitting or corrosion

(*d*) bent, twisted, distorted, stretched, elongated, cracked, or broken load bearing components

(*e*) excessive nicks or gouges

(*f*) a 10% reduction of the original or catalog dimension at any point

(*g*) evidence of unauthorized welding or modification

(*h*) for swivels, lack of the ability to freely rotate when not loaded

(*i*) for swivels, loose or missing nuts, bolts, cotter pins, snap rings, or other fasteners and retaining devices

(*j*) other conditions, including visible damage that cause doubt as to continued use

26-4.8.5 Repairs and Modifications

(*a*) Repairs, alterations, or modifications shall be as specified by the link, ring, or swivel manufacturer or a qualified person.

(*b*) Replacement parts shall meet or exceed the original equipment manufacturer's specifications.

SECTION 26-4.9: OPERATING PRACTICES

26-4.9.1 Links, Rings, and Swivels Selection

(*a*) Links, rings, and swivels having suitable characteristics for the type of load, hitch, angle of loading, and environment shall be selected in accordance with the recommendations of the hardware manufacturer or a qualified person.

NOTE: The angle of loading affects the load on the links, rings, and swivels. As the horizontal angle decreases, the effective load increases (see Fig. 14).

(*b*) The rated load of the links, rings, and swivels shall not be exceeded.

(*c*) Links, rings, and swivels that appear to be damaged shall not be used until inspected and accepted as usable under para. 26-4.8.4.

26-4.9.2 Cautions to Personnel

(*a*) All portions of the human body shall be kept from between the links, rings, and swivels, the load, and any other rigging during the lift.

(*b*) Personnel should stand clear of the suspended load.

(*c*) Personnel shall not ride links, rings, and swivels.

26-4.9.3 Storage & Work Environments

(*a*) Links, rings, and swivels should be stored in an area where they will not be subjected to damage, corrosive action, or extreme temperatures.

(*b*) If extreme temperatures or chemically active environments are involved, the guidance provided in paras. 26-4.6.1 or 26-4.6.2 shall be followed.

26-4.9.4 Rigging Practices

26-4.9.4.1 Links and Rings

(*a*) Alterations or modifications shall comply with para. 26-4.8.5(a).

(*b*) Contact with obstructions that could damage the link or ring should be avoided.

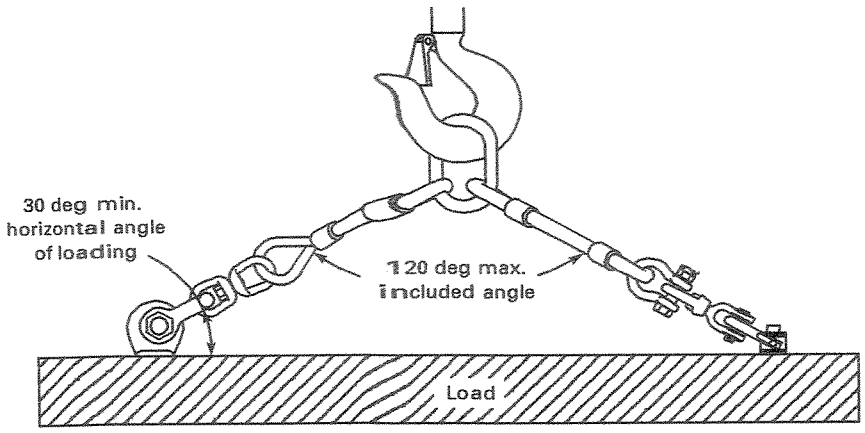
(*c*) Shock loading should be avoided.

(*d*) Links and rings should not be dragged on an abrasive surface.

(*e*) The link or ring shall be of the proper shape and size to ensure that it seats properly in the hook or lifting device.

(*f*) Multiple slings or rigging hardware gathered in a link or ring shall not exceed a 120 deg included angle (see Fig. 14).

(*g*) The horizontal angle of loading should not be less than 30 deg unless approved by a qualified person (see Fig. 14).



Horizontal Angle, deg	Stress Multiplier
90	1.000
60	1.155
45	1.414
30	2.000

Fig. 14 Angle of Loading (Links, Rings, and Swivels)

26-4.9.4.2 Swivels

(*a*) Swivels are positioning hardware and are not intended to be rotated under load.

(*b*) Swivels shall only be used for in-line loads (see Fig. 13).

(*c*) Components shall be maintained in good working condition.

(*d*) Alterations or modifications shall comply with para. 26-4.8.5(a).

(*e*) Shock loading should be avoided.

(*f*) Swivels shall be of the proper shape and size to ensure that they seat properly in the hook or lifting device.

(*g*) Contact with obstructions that could damage the swivel should be avoided.

Chapter 26-5
Rigging Blocks – Selection, Use, and Maintenance

SECTION 26-5.0: SCOPE

This Chapter applies to rigging blocks. Crane blocks are covered by crane type under other ASME B30 volumes.

SECTION 26-5.1: TYPES AND MATERIALS

26-5.1.1 Types

(*a*) Types include tackle, utility, rolling, and snatch blocks (see Fig. 15).

(*b*) Load fittings on rigging blocks may include hooks, eyes, swivels, yokes, bails, shackles, and pins (see Fig. 16).

(*c*) Rigging blocks other than those detailed in this Chapter shall be used in accordance with recommendations of the manufacturer or a qualified person.

26-5.1.2 Materials

(*a*) The rigging block shall have sufficient ductility to permanently deform before losing the ability to support the load at the temperatures that the manufacturer has specified for use.

(*b*) The shell or side plates shall be metal, wood, or synthetic.

(*c*) The sheave(s) shall be metal or synthetic.

(*d*) The load bearing straps and fitting(s) shall be made of metal.

SECTION 26-5.2: DESIGN FACTOR

The design factor for rigging blocks shall be a minimum of 4.

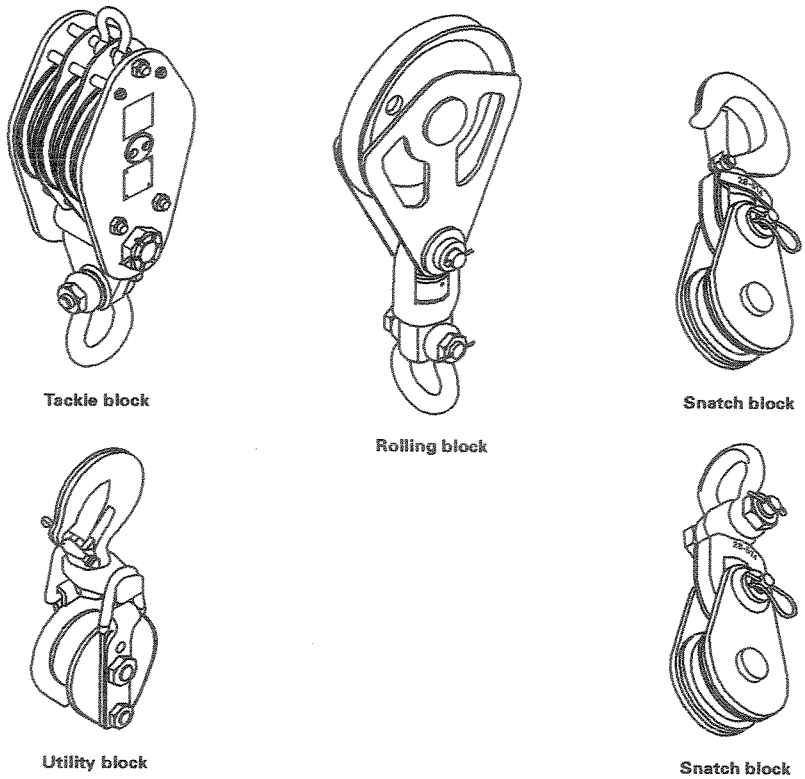


Fig. 15 Rigging Block Types

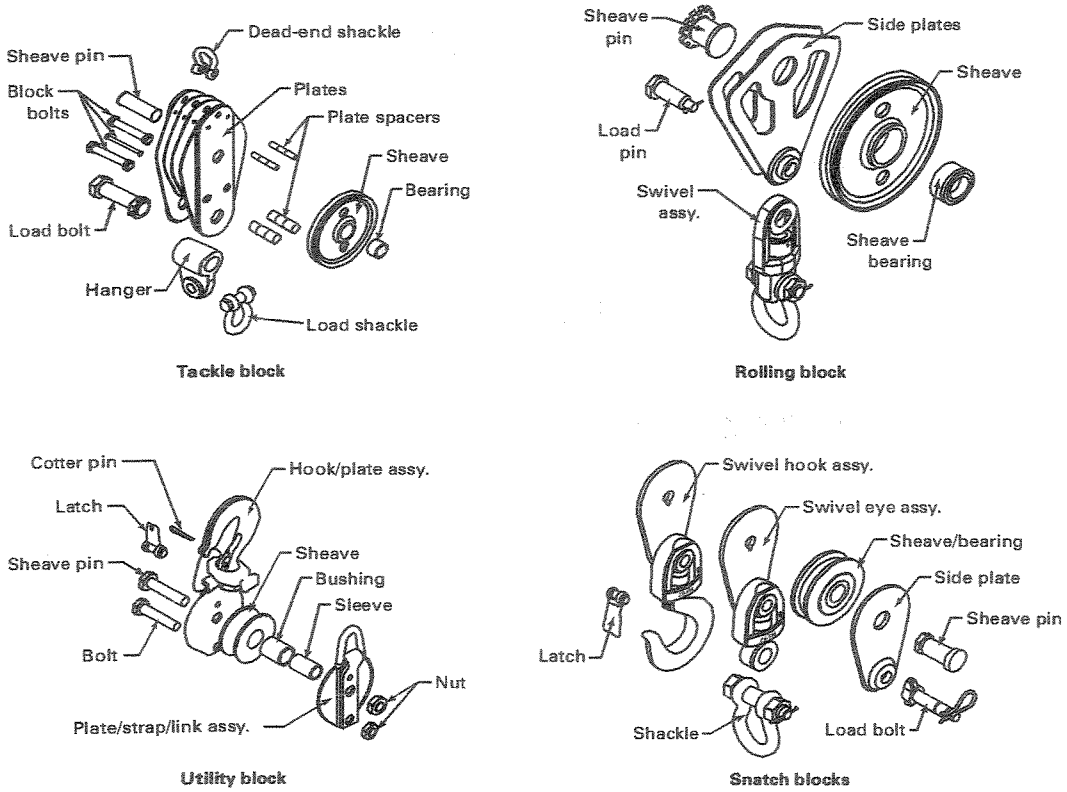


Fig. 16 Typical Rigging Block Components

SECTION 26-5.3: RATED LOADS

Rated load shall be in accordance with the recommendation of the rigging block manufacturer. The terms "rated capacity" and "working load limit" are commonly used to describe rated load.

Note: **The block rated load is the maximum load applied to the primary load fitting, not the line pull (see Fig. 17).**

SECTION 26-5.4: PROOF TEST

26-5.4.1 Proof Test Requirements

(*a*) Rigging blocks are not required to be proof tested unless specified by the purchaser.

(*b*) If proof tested, a rigging block shall be inspected after the test for the conditions stated in para. 26-5.8.4.

26-5.4.2 Proof Load Requirements

The proof load for a rigging block shall be a minimum of 1.5 and a maximum of 2 times the rated load unless approved by the manufacturer or a qualified person.

SECTION 26-5.5: IDENTIFICATION

26-5.5.1 Marking

Each new rigging block shall be marked by the manufacturer to show:

(*a*) name or trademark of manufacturer
(*b*) rated load
(*c*) rope size(s)

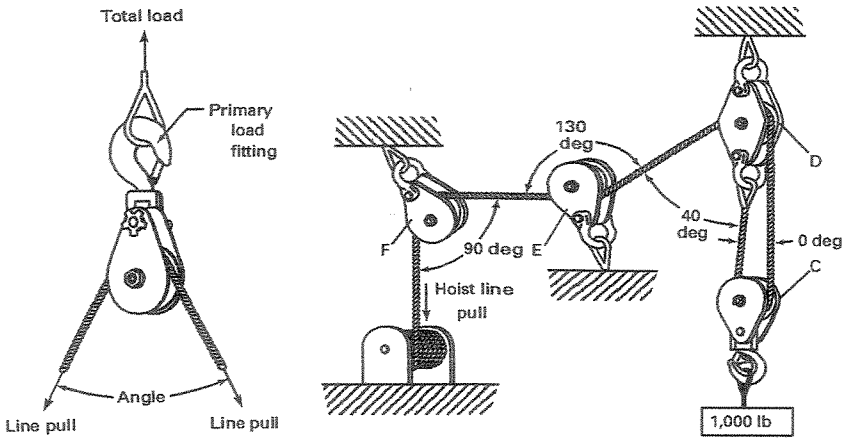
26-5.5.2 Maintenance of Identification

Rigging block identification should be maintained by the user so as to be legible throughout the life of the block.

SECTION 26-5.6: EFFECTS OF ENVIRONMENT

26-5.6.1 Temperature

When rigging blocks are to be used at temperatures above 150°F (66°C) or below 0°F (−18°C), the rigging block manufacturer or a qualified person should be consulted.



Multipliers

Angle, deg	Factor	Angle, deg	Factor
0	2.00	100	1.29
10	1.99	110	1.15
20	1.97	120	1.00
30	1.93	130	0.84
40	1.87	135	0.76
45	1.84	140	0.68
50	1.81	150	0.52
60	1.73	160	0.35
70	1.64	170	0.17
80	1.53	180	0.00
90	1.41	—	—

Block Load = Line Pull × Multiplier Factor

Example: Load = 1,000 lb
Line Pull: 1,000 lb ÷ 2 = 500 lb
Load Block "C" = 500 lb × 2 = 1,000 lb
(line pull × factor for 0 deg angle)
Load Block "D" = 500 lb × 1.87 + 500 lb = 1,435 lb
(line pull × factor for 40 deg angle + dead-end load)
Load Block "E" = 500 lb × 0.84 = 420 lb
(line pull × factor for 130 deg angle)
Load Block "F" = 500 lb × 1.41 = 705 lb
(line pull × factor for 90 deg angle)

Fig. 17 Block Load Factor Multipliers

26-5.6.2 Chemically Active Environments

Chemically active environments such as caustic or acid substances or fumes can affect the strength, operating characteristics, or both, of rigging blocks. The rigging block manufacturer or a qualified person should be consulted when rigging blocks are used in chemically active environments.

SECTION 26-5.7: TRAINING

Rigging block users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

SECTION 26-5.8: INSPECTION, REPAIR, AND REMOVAL

26-5.8.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired rigging blocks shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter. Written records are not required.

26-5.8.2 Frequent Inspection

(*a*) A visual inspection shall be performed by the user or other designated person each shift before the rigging block is used. Semi-permanent and inaccessible locations where frequent inspections are not feasible shall have periodic inspections performed.

(*b*) Conditions such as those listed in para. 26-5.8.4, or any other condition that may result in a hazard, shall cause the rigging block to be removed from service. Rigging blocks shall not be returned to service until approved by a qualified person.

(*c*) Written records are not required.

26-5.8.3 Periodic Inspection

(*a*) A complete inspection of the rigging block shall be performed by a designated person. The hardware shall be examined for conditions such as those listed in para. 26-5.8.4 and a determination made as to whether they constitute a hazard.

(*b*) *Periodic Inspection Frequency.* Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on

(*1*) frequency of use

(2) severity of service conditions
(3) nature of lifts being made
(4) experience gained on the service life of hardware used in similar circumstances
(5) Guidelines for the time intervals are
(*a*) normal service – yearly
(*b*) severe service – monthly to quarterly
(*c*) special service – as recommended by a qualified person
(*c*) Written records are not required.

26-5.8.4 Removal Criteria

Rigging blocks shall be removed from service if conditions such as the following are present and shall only be returned to service when approved by a qualified person:
(*a*) missing or illegible identification
(*b*) misalignment or wobble in sheaves
(*c*) excessive sheave groove corrugation or wear
(*d*) loose or missing nuts, bolts, cotter pins, snap rings, or other fasteners and retaining devices
(*e*) indications of heat damage, including weld spatter or arc strikes
(*f*) excessive pitting or corrosion
(*g*) bent, cracked, twisted, distorted, stretched, elongated, or broken load bearing components
(*h*) excessive wear, nicks, or gouges
(*i*) a 10% reduction of the original or catalog dimension at any point
(*j*) excessive damage to load bearing threads
(*k*) evidence of unauthorized welding or modifications
(*l*) for hooks, the removal criteria specified in B30.10
(*m*) for shackles, the removal criteria specified in B30.26
(*n*) other conditions, including visible damage that cause doubt as to the continued use of the rigging block

26-5.8.5 Repairs and Modifications

(*a*) Repairs, alterations, or modifications shall be as specified by the rigging block manufacturer or a qualified person.
(*b*) Replacement parts, such as pins, hooks and sheaves, shall meet or exceed the original equipment manufacturer's specifications.

SECTION 26-5.9: OPERATING PRACTICES

26-5.9.1 Rigging Block Selection

(*a*) Rigging blocks having suitable characteristics for the application and environment shall be selected in accordance with the recommendations of the rigging block manufacturer or a qualified person.
(*b*) The rated load of the rigging block shall not be exceeded.

NOTE: The included angle formed between the load lines affects the load on the block. As the included angle decreases, the load increases in the rigging block (see Fig. 16).

(*c*) Rigging blocks that appear to be damaged shall not be used until inspected and accepted as usable under para. 26-5.8.4.
(*d*) The minimum D/d ratio between the sheave pitch diameter and the wire rope diameter is 6.

26-5.9.2 Cautions to Personnel

(*a*) All portions of the human body shall be kept from between the rigging block, its running lines, the load, and any other rigging during the lift.
(*b*) Personnel should stand clear of the suspended load.
(*c*) Personnel shall not ride rigging blocks.

26-5.9.3 Storage & Work Environments

(*a*) Rigging blocks should be stored in an area where they will not be subjected to damage, corrosive action, or extreme temperatures.
(*b*) If extreme temperatures or chemically active environments are involved, the guidance provided in paras. 26-5.6.1 or 26-5.6.2 shall be followed.

26-5.9.4 Rigging Practices

(*a*) The rigging block components shall be fully engaged, with all fasteners and retaining devices in place and in good working order before use. Alterations or modifications shall comply with para. 26-5.8.5.
(*b*) Contact with sharp edges that could damage the rigging block should be avoided.
(*c*) Shock loading should be avoided.
(*d*) The load applied to the rigging block should be in-line with the sheave and load fitting(s) to prevent side loading of the block.
(*e*) Ensure the rope is in the sheave groove when the rigging block begins to take load.
(*f*) The line load multiplied by the block load factor shall not exceed the rated load of the rigging block (see Fig. 17).
(*g*) Rigging blocks should not be dragged on an abrasive surface.
(*h*) Load line fittings shall not contact the rigging block sheave(s).

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ANSI B30.9

Slings

AN AMERICAN NATIONAL STANDARD

SAFETY STANDARD FOR CABLEWAYS, CRANES, DERRICKS
HOISTS, HOOKS, JACKS, AND SLINGS

ASME B30.9c-2000

ADDENDA

to

ASME B30.9-1996
SLINGS

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Three Park Avenue • New York, NY 10016-5990

Date of Issuance: November 15, 2000

This code or standard was developed under procedures accredited as meeting the criteria for American National Standards. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

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The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

ASME B30.9c-2000

Following approval by the ASME B30 Committee and ASME, and after public review, ASME B30.9c-2000 was approved by the American National Standards Institute on January 3, 2000.

Addenda to the 1996 edition of ASME B30.9 are issued in the form of replacement pages. Revisions, additions, and deletions are incorporated directly into the affected pages. It is advisable, however, that this page, the Addenda title and copyright pages, and all replaced pages be retained for reference.

SUMMARY OF CHANGES

This is the third Addenda to be published to ASME B30.9-1996. Previous Addenda were published in 1997 and 1998.

Replace or insert the pages listed. Changes given below are identified on the pages by a margin note, **(c)**, placed next to the affected area. Previous Addenda changes are indicated by **(a)** and **(b)**. The pages not listed are the reverse sides of the listed pages and contain no changes.

Page	*Location*	*Change*
x, xi	Contents	Revised to reflect Addenda changes
1	General	Listing of B30 volumes updated
	Footnote 1	Revised
5–8	Section 9-0.2	(1) Term and definition of *angle of inclination* deleted (2) Terms *assembly*, *hitch (hitched)*, *ply*, and *shock load* added (3) Definition of *sling* revised
	Section 9-0.3	Reference for ASTM A 973-97/A 973M-97 added
14	Fig. 7	Caption to Type VI sketch revised
15	Fig. 8	Figure and title revised
16.1	Fig. 10	New Fig. 10 added
17–22	9-1.1	(1) New 9-1.1.2 added (2) 9-1.1.2 through 9-1.1.4 redesignated as 9-1.1.3 through 9-1.1.5, respectively (3) Reference to ASTM A 973/A 973M added to newly designated 9-1.1.3
	9-1.3.1	Revised
	9-1.3.2	Subparagraphs (a) and (b) revised
	9-1.3.3	Revised

Page	*Location*	*Change*
	9-1.4.1	Subparagraphs (a) through (d) revised
	9-1.4.2(a)	Revised
	Table 1	Revised
	Table 2	(1) New table added (2) Previously designated Table 2 revised and redesignated as Table 3
	Section 9-1.5	Revised in its entirety
	9-1.6.1	Revised
	9-1.8.3(a)	Subsubparagraphs (a)(1) and (a)(2) revised
	Section 9-1.9	(1) Subparagraphs (a), (c), (h), (s), and (t) revised (2) New subpara. (x) added
23–34	9-2.1.1	Revised
	Section 9-2.3	(1) Second paragraph revised (2) Subparagraphs (d), (f), and (i) revised
	9-2.4.1	Revised
	9-2.4.2	Revised
	Footnote 1	Revised
	Table 3	Redesignated as Table 4 and revised
	Table 4	Redesignated as Table 5 and revised
	Table 5	Redesignated as Table 6 and revised
	Table 7	(1) New Table 7 added (2) Previously designated Table 6 revised and redesignated as Table 8 (3) Previously designated Table 7 revised and redesignated as Table 9
	Table 8	Redesignated as Table 10 and revised
	Table 9	Redesignated as Table 11 and revised
	Fig. 10	(1) Sketch at left revised (2) Redesignated as Fig. 11
	Fig. 11	Redesignated as Fig. 12
	9-2.4.3	Revised
	9-2.4.4	Revised
	Section 9-2.5	Revised in its entirety

Page	*Location*	*Change*
	9-2.8.3(b)	(1) New subsubpara. (b)(1) added (2) Subsubparagraphs (b)(1) through (b)(8) redesignated as (b)(2) through (b)(9), respectively (3) Textabular material following newly redesignated (b)(9) revised
	Section 9-2.9	(1) Subparagraphs (h) and (s) revised (2) New subpara. (ab) added
35–37	9-3.1.1	Revised
	9-3.3.1	Revised
	9-3.3.2	Revised
	9-3.3.3	Revised
	Section 9-3.4	Revised
	Section 9-3.5	Revised in its entirety
	Table 10	Redesignated as Table 12
	9-3.8.4	(1) Subparagraph (j) redesignated as subpara. (a) (2) Subparagraphs (a) through (i) redesignated as (b) through (j), respectively
	Section 9-3.9	(1) Subparagraph (g) revised (2) New subpara. (v) added
38	Table 11	Redesignated as Table 13 and revised
39, 40	9-4.3.1	Revised
	9-4.3.2	Revised
	Section 9-4.4	Revised
	9-4.5.2	Revised
	9-4.5.3	Added
	9-4.6.1	Revised
41, 42	9-4.8.4	(1) Subparagraph (i) redesignated as subpara. (a) (2) Subparagraphs (a) through (h) redisgnated as (b) through (i), respectively (3) Newly redesignated subpara. (d) revised
	Section 9-4.9	Subparagraphs (g) and (w) revised
43–45	Tables 12–15	Redesignated as Tables 14–16
47	Section 9-5.3	Subparagraphs (a), (d), and (e) revised
	Footnote 1	Revised
48	Section 9-5.4	Subparagraphs (a) and (b) revised

Page	*Location*	*Change*
	Section 9-5.5	Revised in its entirety
	9-5.6.2	Revised
	9-5.8.4	(1) Subparagraph (i) redesignated as subpara. (a) (2) Subparagraphs (a) through (h) redesignated as (b) through (i), respectively
49	Section 9-5.9	Subparagraphs (h) and (v) revised
50	Tables 15 and 16	Redesignated as Tables 17 and 18, and revised
51	Tables 17 and 18	Redesignated as Tables 19 and 20, and revised
51.1	Tables 21 and 22	Added
51.2	Tables 23 and 24	Added
52.1	9-6.1.5	Revised
	9-6.3.2	First paragraph revised
	9-6.3.3	Revised
	9-6.3.4	Revised
	Section 9-6.4	Subparagraphs (a) and (b) revised
52.2	Fig. 12	Redesignated as Fig. 13
52.3	Table 19	(1) Redesignated as Table 25 (2) Title and column heads revised (3) In Vertical Hitch [Note (3)] column, third entry for lb corrected by errata
52.4	Fig. 13	Redesignated as Fig. 14 and revised
	Section 9-6.5	Revised in its entirety
52.5	Section 9-6.9	Subparagraph (g) revised

SPECIAL NOTE

The interpretations to ASME B30.9 are included as a separate section for the user's convenience.

CONTENTS

(c)

Figures

SAFETY STANDARD FOR CABLEWAYS, CRANES, DERRICKS, HOISTS, HOOKS, JACKS, AND SLINGS

INTRODUCTION

(96) (a) (b) (c)

General

This Standard is one of a series of safety standards on various subjects which have been formulated under the general auspices of the American National Standards Institute. One purpose of the Standard is to serve as a guide to governmental authorities having jurisdiction over subjects within the scope of the Standard. It is expected, however, that the Standard will find a major application in industry, serving as a guide to manufacturers, purchasers, and users of the equipment.

For the convenience of the user, the Standard has been divided into separate volumes:

B30.1 Jacks
B30.2 Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
B30.3 Construction Tower Cranes
B30.4 Portal, Tower, and Pedestal Cranes
B30.5 Mobile and Locomotive Cranes
B30.6 Derricks
B30.7 Base Mounted Drum Hoists
B30.8 Floating Cranes and Floating Derricks
B30.9 Slings
B30.10 Hooks
B30.11 Monorails and Underhung Cranes
B30.12 Handling Loads Suspended From Rotorcraft
B30.13 Storage/Retrieval (S/R) Machines and Associated Equipment
B30.14 Side Boom Tractors
B30.15 Mobile Hydraulic Cranes
Note: B30.15-1973 has been withdrawn. The revision of B30.15 is included in the latest edition of B30.5.
B30.16 Overhead Hoists (Underhung)
B30.17 Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
B30.18 Stacker Cranes (Top or Under Running Bridge, Multiple Girder With Top or Under Running Trolley Hoist)
B30.19 Cableways
B30.20 Below-the-Hook Lifting Devices
B30.21 Manually Lever Operated Hoists
B30.22 Articulating Boom Cranes
B30.23 Personnel Lifting Systems
B30.24 Container Cranes[1]
B30.25 Scrap and Material Handlers

If adopted for governmental use, the references to other national codes and standards in the specific volumes may be changed to refer to the corresponding regulations of the governmental authorities.

The use of cableways, cranes, derricks, hoists, hooks, jacks, and slings is subject to certain hazards that cannot be met by mechanical means but only by the exercise of intelligence, care, and common sense. It is therefore essential to have personnel involved in the use and operation of equipment who are competent, careful, physically and mentally qualified, and trained in the safe operation of the equipment and the handling of the loads. Serious hazards are overloading, dropping or slipping of the load caused by improper hitching or slinging, obstructing the free passage of the load, and using equipment for a purpose for which it was not intended or designed.

The Standards Committee fully realizes the importance of proper design factors, minimum or maximum sizes, and other limiting dimensions of wire rope or chain and their fastenings, sheaves, sprockets, drums, and similar equipment covered by the Standard, all of which are closely connected with safety. Sizes, strengths, and similar criteria are dependent on many different factors, often varying with the installation and uses. These factors depend on the condition of the equipment or material; on the loads; on the acceleration or speed of the ropes, chains, sheaves, sprockets, or drums; on the type of attachments; on the number, size, and arrangement of sheaves or other parts; on environmental conditions causing corrosion or wear; and on many variable factors that must be considered in each individual case. The rules given in the Standard must be

[1] B30.24 is in the developmental stage.

(96) (b) (c)

interpreted accordingly, and judgment used in determining their application.

Some of the provisions of this Standard require compliance with information found in manuals or other documents supplied by the manufacturer with the equipment. The information includes recommendations, requirements, and instructions (e.g., "the reeving shall be checked for compliance with the recommendations of the manufacturer").

Compliance with the provisions should not preclude the possibility of consulting a qualified person. This is true particularly when: the equipment has been altered, repaired, or modified; the manuals or documents supplied by the manufacturer are no longer available; or the manufacturer or a successor is no longer in business and the manuals are no longer available. However, the purpose of consulting a qualified person shall not be to avoid contacting the manufacturer and using the information supplied by the manufacturer.

The Standards Committee will be glad to receive criticisms of this Standard's requirements and suggestions for its improvement, especially those based on actual experience in application of the rules.

Suggestions for changes to the Standard should be submitted to the Secretary of the B30 Committee, ASME, Three Park Avenue, New York, NY 10016-5990, and should be in accordance with the following format:

(a) cite the specific paragraph designation of the pertinent volume;

(b) indicate the suggested change (addition, deletion, revision, etc.);

(c) briefly state the reason and/or evidence for the suggested change;

(d) submit suggested changes to more than one paragraph in the order that the paragraphs appear in the volume.

The B30 Committee will consider each suggested change in a timely manner in accordance with its procedures.

Section I: Scope

This Standard applies to the construction, installation, operation, inspection, and maintenance of jacks; power-operated cranes, monorails, and crane runways; power-operated and manually operated derricks and hoists; lifting devices, hooks, and slings; and cableways.

This Standard does not apply to track and automotive jacks, railway or automobile wrecking cranes, shipboard cranes, shipboard cargo-handling equipment, well-drilling derricks, skip hoists, mine hoists, truck body hoists, car or barge pullers, conveyors, excavating equipment, or equipment coming within the scope of the following Committees: A10, A17, A90, A92, A120, B20, B56, and B77.

Section II: Purpose

This Standard is designed to:

(a) guard against and minimize injury to workers, and otherwise provide for the protection of life, limb, and property by prescribing safety requirements;

(b) provide direction to owners, employers, supervisors, and others concerned with, or responsible for, its application; and

(c) guide governments and other regulatory bodies in the development, promulgation, and enforcement of appropriate safety directives.

Section III: Interpretations

Upon request, the B30 Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B30 Committee, ASME, Three Park Avenue, New York, NY 10016-5990.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his request utilizing the following format.

Subject: Cite the applicable paragraph number(s) and provide a concise description.

Edition: Cite the applicable edition of the pertinent volume for which the interpretation is being requested.

Question: Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for approval of a proprietary design or situation. The inquirer may also include any plans or drawings which are necessary to explain the question; however, they should not contain any proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which could change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information which might affect an interpretation is available. Further,

SLINGS

CHAPTER 9-0
Scope, Definitions, and References

(a) Section 9-0.1: Scope of B30.9

Within the general scope defined in Section I, B30.9 applies to slings for lifting purposes, made from alloy steel chain, sewn synthetic webbing, wire rope, metal mesh, and synthetic fiber rope used in conjunction with equipment described in other volumes of the B30 Standard, except as specified in ASME B30.12. Slings made from materials or constructions other than those detailed in this volume shall be used only in accordance with recommendations of the sling manufacturer.

Section 9-0.2: Definitions

abnormal operating conditions: environmental conditions that are unfavorable, harmful, or detrimental to or for the operation of a sling, such as excessively high or low ambient temperatures; exposure to weather; corrosive fumes; dust laden or moisture laden atmospheres; and hazardous locations.

abrasion: the mechanical wearing of a surface resulting from frictional contact with other materials or objects

angle of choke (wire rope slings): angle formed in wire rope body as it passes through the choking eye (see Fig. 8)

(c)

(b) *angle of loading:* slope of a leg or branch of a sling, may be measured from the horizontal or vertical plane. When angle of loading is less than 5 deg. from the vertical, the load may be considered a vertical load.

(c) *assembly:* a synonym for sling (see *sling*)

authorized: approved by a duly constituted administrative or regulatory authority

body: that part of a sling which is between the end fittings or loop eyes

braided wire rope: a rope formed by plaiting component wire ropes

braided wire rope sling: a sling made from braided rope

bridle sling: a sling composed of multiple legs with the top ends gathered in a fitting that goes over the lifting hook

cable laid rope: a cable composed of six wire ropes laid as strands around a wire rope core

cable laid rope sling, mechanical joint: a wire rope sling made from a cable laid wire rope with eyes fabricated by pressing or swaging one or more metal sleeves over the rope junction

coatings

metal mesh sling coatings: a paint, plating, or impregnation or molding with elastomer to impart desirable properties for the sling application

synthetic web sling coatings: a finish that will impart characteristics such as:

(a) abrasion resistance;

(b) sealing to impede penetration of foreign particles and matter;

(c) increased coefficient of friction.

cross rod: a wire used to join spirals of metal mesh to form the complete fabric (see Fig. 3)

design factor: ratio between nominal or minimum breaking strength and rated capacity of the sling

designated person: a person selected or assigned by the employer or employer's representative as being competent to perform specific duties (a)

eight-strand plaited: a rope made from eight strands arranged in four pairs in which one strand is placed adjacent to the second pair and in which each strand of each pair has been twisted in one direction while each strand in each alternate pair has been twisted in the opposite direction and the four pairs of strands are intertwined maypole fashion such that each pair of strands passes over and under an adjacent pair of strands. (a)

end fitting: terminal hardware on the end of a sling

endless and grommet wire rope slings

cable laid endless sling, mechanical joint: a wire rope sling made endless from one continuous length of cable laid rope with the ends joined by one or more metallic fittings

cable laid grommet, hand tucked: an endless wire rope sling made from one continuous length of rope formed to make a body composed of six ropes around a rope core. The rope ends are tucked into the body, thus forming the core. No sleeves are used.

strand laid endless sling, mechanical joint: a wire rope sling from one continuous length of wire rope with the ends joined by one or more metallic fittings

strand laid grommet, hand tucked: an endless wire rope sling made from one continuous length of strand formed to make a six strand rope with a strand core. The strand ends are hand tucked into the body. No sleeves are used.

eye opening: the opening in the end of a sling for the attachment of the hook, shackle, or other lifting device or the load itself

fabric (metal mesh): the flexible portion of the sling consisting of a series of transverse spirals and cross rods and exclusive of terminal fittings (see Fig. 3)

fabric length (metal mesh): length of the fabric measured between the extreme ends of the spirals (see Fig. 4)

fabric thickness (metal mesh): the fabric thickness shall be the nominal overall thickness of the spirals (see Fig. 3)

fabrication efficiency: the sling assembly strength, as a percentage of the material strength prior to fabrication

grommet sling: a variety of an endless sling (see *endless and grommet wire rope slings*)

(b) *hitch, basket:* a method of rigging a sling in which the sling is passed around the load and both loop eyes or end fittings are attached to the lifting device (see *angle of loading*).

(c) *hitch (hitched):* a method of rigging (attaching) a sling temporarily to a load or object for the purpose of lifting

(b) *hitch, choker:* a method of rigging a sling in which the sling is passed around the load, then through one loop eye, end fitting, or other device with the other loop eye or end fitting attached to the lifting device. This hitch can be done with a sliding choker hook or similar device (see *angle of loading*).

hitch, vertical: a method of rigging a sling in which the load is attached to the loop eye or end fitting at one end of the sling and the loop eye or end fitting at the other end is attached to the lifting device (see *angle of loading*). (b)

hollow braided: a braided rope construction of either plain or twill braid whereby the strands are intertwined maypole fashion, half of the strands turn clockwise and, alternately, half counterclockwise. The center is hollow. On the surface all strands are inclined to the axis of the rope. (a)

length (alloy steel chain): see *reach (alloy steel chain)*

length (metal mesh), pull to pull or bearing to bearing: length of metal mesh sling measured between bearing surfaces of the end fittings (see Fig. 4)

length, wire rope

single leg slings without end fittings: measured from pull to pull or from bearing to bearing of eyes

single leg slings with end fittings: measured from pull to pull of integral fitting, thimble, or eye at the opposite end. If zinc-attached sockets are used, measurement is from the pull of the closed socket to the center line of the open socket pin. If swaged sockets are used, measurement is from center line of pin to center line of pin.

multiple leg slings: same as above, except that the gathering ring, master link, or similar fitting is not included in the length dimension

length (web sling — synthetic): the distance between extreme end bearing points of the sling, including the fittings (see Fig. 5)

link, master: forged or welded steel link used to support all members (legs) of an alloy steel chain or wire rope sling (see Fig. 6)

link, master coupling: alloy steel welded coupling link used as an intermediate link to join alloy steel chain to master links (see Fig. 6)

link, mechanical coupling (alloy steel chain): a non-welded, mechanically closed link used primarily to attach master links, hooks, etc., to running length alloy steel chain

loop eye (web sling): a length of webbing which has been folded back upon itself, forming an opening, and joined to the sling body to form a bearing surface (see Fig. 5)

ply: a layer of load bearing webbing used in a web sling assembly (c)

proof load: the specific load applied in performance of the proof tests

proof test: a nondestructive load test made to a specific multiple of the rated load of the sling

(b) *qualified person:* a person who, by possession of a recognized degree in an applicable field, or certificate of professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work

(a) *rated load:* the maximum allowable working load established by the sling manufacturer. (When using a multiple branch sling, the rating shown for the single branch sling shall not be exceeded in any branch of the multiple branch sling.) The terms "rated capacity" and "working load limit" are commonly used to describe rated load.

reach (alloy steel chain): effective length of an alloy steel chain sling measured between the bearing surfaces of the end fittings (see Fig. 6)

selvage edge: the woven or knitted edge of synthetic webbing so formed as to prevent raveling

(c) *shock load:* any condition of rapid lift, sudden shifting of load, or arrest of a falling load

(c) *sling:* an assembly used for lifting when connected to a lifting mechanism. The upper portion is connected to the lifting mechanism and the lower supports the load, as described in the chapters of this volume.

sling manufacturer (fabricator): a person or company assembling or fabricating sling components into their final form for actual use. The sling manufacturer and the manufacturer of the sling material (alloy steel chains, wire rope, metal mesh webbing, fiber rope, or synthetic webbing) may or may not be identical.

sling service

normal: service that involves use of loads within the rated load

severe: service that involves normal service coupled with abnormal operating conditions

special or infrequent: service that involves operation, other than normal or severe, which is recommended by a qualified individual

spiral: a single transverse coil which is the basic element from which metal mesh is fabricated

splice (web sling): that part of a sling which is lapped and secured to become an integral part of the sling (see Fig. 5). Types of splices are as follows:

assembly splice: any splice that joins two or more parts of the sling without bearing any of the applied load [see Fig. 5(b)];

load-bearing splice: any splice that carries a portion of the total load applied.

splice, hand tucked: a loop or eye formed in the end of a rope by tucking the end of the strands back into the main body of the rope in a prescribed manner

splice, mechanical: a loop or eye formed in the end of a wire rope by pressing or swaging one or more metal sleeves over the wire rope junction

strand laid rope: a wire rope made with strands (usually 6 or 8) formed around a fiber core, wire strand core, or independent wire rope core (IWRC)

strength, minimum breaking: minimum load at which a new sling or component will break when loaded to destruction in direct tension

strength, nominal: load at which a new sling or component could be expected to break when loaded to destruction in direct tension

tagline: a restraining line to control position of the load

three-strand laid: a rope constructed by laying three strands together. Each strand is twisted or laid but with the opposite direction of the lay of the rope. This rope is often called "three strand." (a)

triangle choker fitting: an end fitting for metal mesh or synthetic web slings; similar to the *triangle fittings* except that it also has a transverse slot through which a triangle fitting can be passed to facilitate a choker hitch on the load.

triangle fitting: an end fitting for metal mesh or synthetic web slings, containing a single eye opening, for connecting the sling to the lifting device

yarn (web slings): the synthetic fiber which is used to make the webbing and thread

Section 9-0.3: References to Other Publications (96)

(a)

(b)

(c)

Within the text, references are made to the following publications, copies of which may be obtained from the publishers as indicated.

Federal Specification RR-W-410, Wire Rope and Strand

Military Specification MIL-W-83420, Wire Rope, Flexible, for Aircraft Control

Publisher: U.S. Government Printing Office, Washington, D.C. 20402

ASME B30.10-1993, Hooks[1]

ASME B30.12-1992, Handling Loads Suspended from Rotorcraft[1]

Publisher: The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990

ASTM A 391-93 (A 391M-93), Standard Specification for Alloy Steel Chain

ASTM A 906-93 (A 906M-93), Standard Specification for Alloy Steel Chain Slings for Overhead Lifting

ASTM A 973-97 (A 973M-97), Standard Specification for Grade 100 Alloy Steel Chain

Publisher: American Society for Testing and Materials, 100 Barr Harbor Drive, W. Conshohocken, PA 19428-2959

CI 1301-96, Polypropylene Fiber Rope, 3-Strand and 8-Strand Construction

CI 1303-96, Nylon (Polyamide) Fiber Rope, 3-Strand and 8-Strand Construction

CI 1304-96, Polyester (PET) Fiber Rope, 3-Strand and 8-Strand Construction

CI 1305-96, Single Braided Polyester Fiber Rope, 12-Strand Braid Construction

CI 1306-96, Nylon (Polyamide) Fiber Rope, Double Braid Construction

CI 1307-96, Polyester (PET) Fiber Rope, Double Braid Construction

Publisher: Cordage Institute, 350 Lincoln Street — 115, Hingham, MA 02043

WRTB Wire Rope Sling Users Manual

Publisher: Wire Rope Technical Board, P.O. Box 849, Stevensville, MD 21666

[1] May also be obtained from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

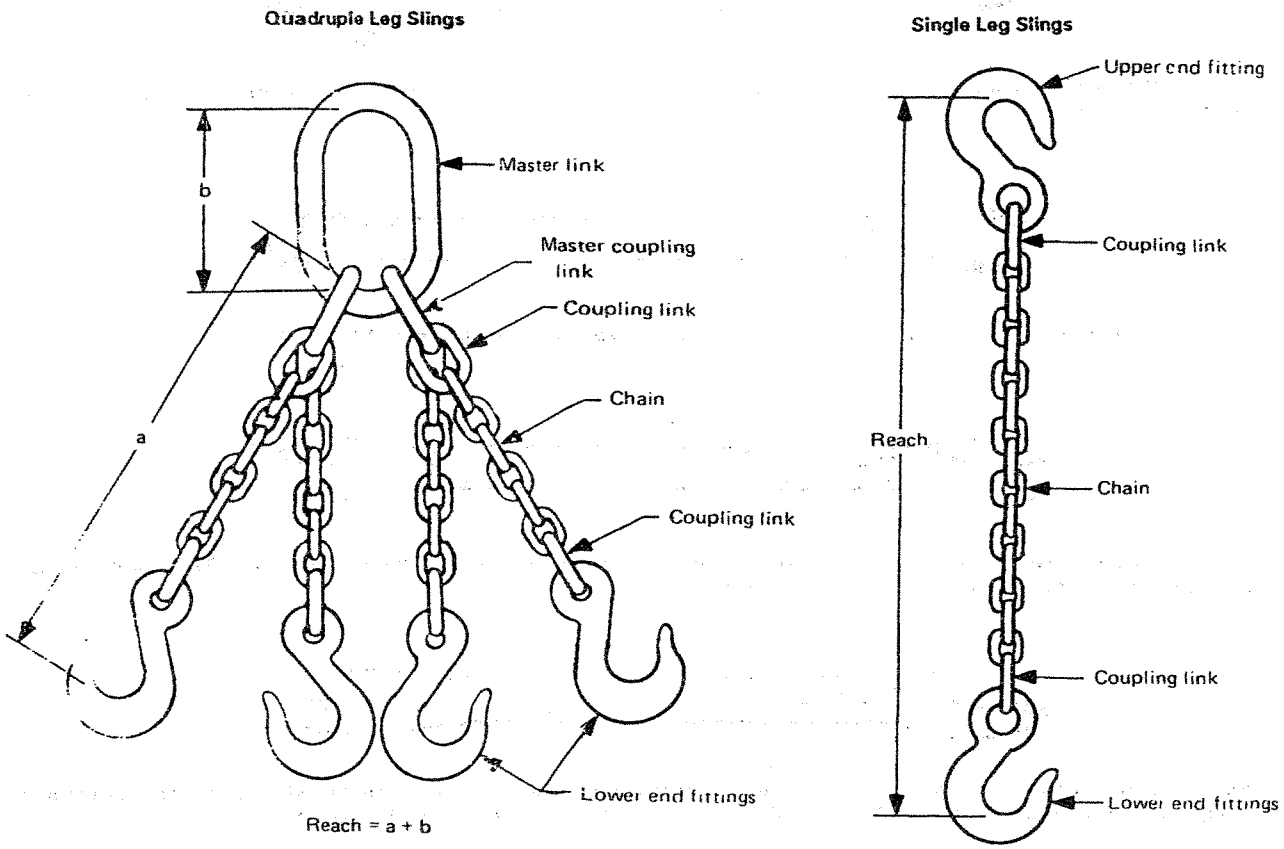
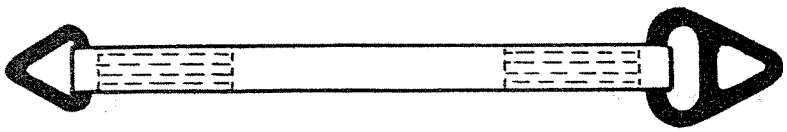
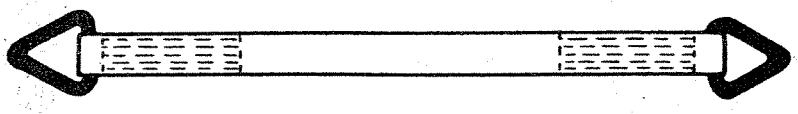


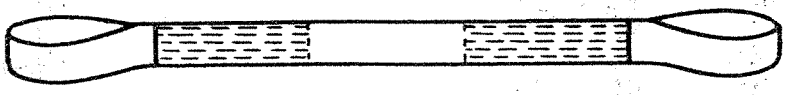
FIG. 6 CHAIN SLING MAJOR COMPONENTS
(Chapter 9-1)



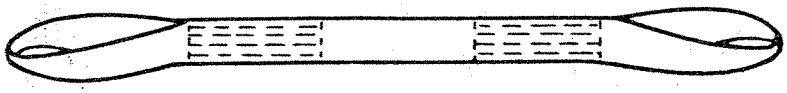
TYPE I Sling made with a triangle fitting on one end and a slotted triangle choker fitting on the other end. It can be used in a vertical, basket, or choker hitch.



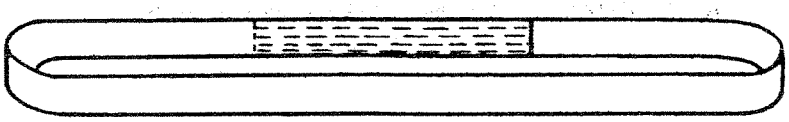
TYPE II Sling made with a triangle fitting on both ends. It can be used in a vertical or basket hitch only.



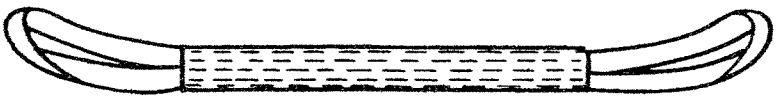
TYPE III Sling made with a flat loop eye on each end with loop eye opening on same plane as sling body. This type of sling is sometimes called a flat eye and eye, eye and eye, or double eye sling.



TYPE IV Sling made with both loop eyes formed as in Type III, except that the loop eyes are turned to form a loop eye which is at a right angle to the plane of the sling body. This type of sling is commonly referred to as a twisted eye sling.

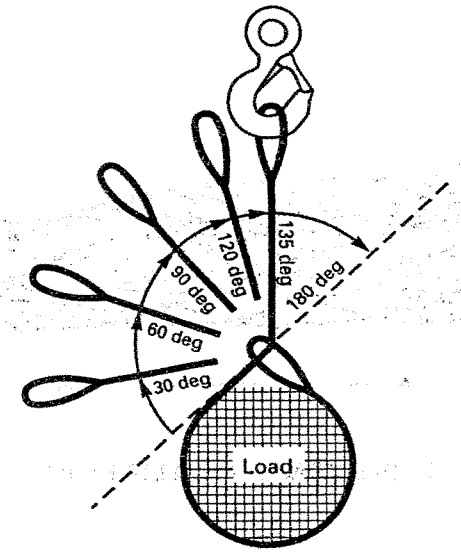


TYPE V Endless sling, sometimes referred to as a grommet. It is a continuous loop formed by joining the ends of the fabric together with a splice.

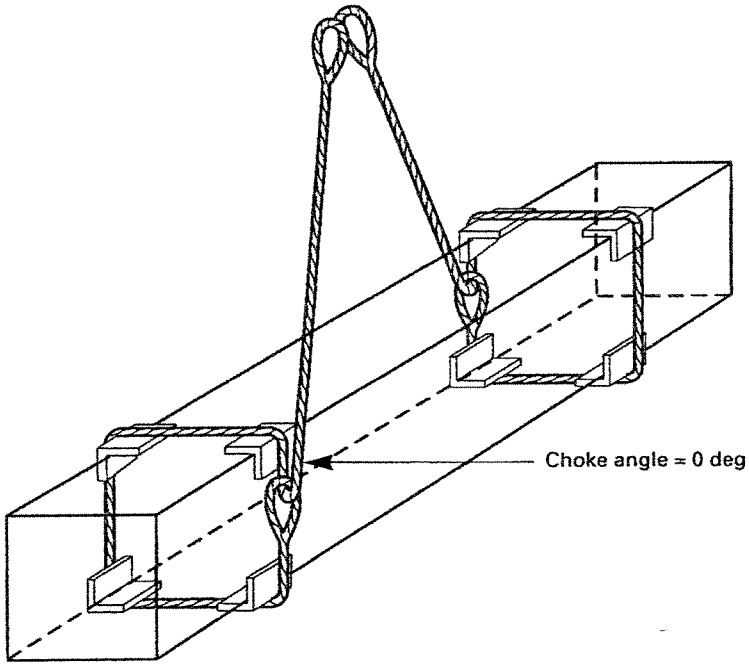


TYPE VI Return eye (reversed eye) sling is formed by using multiple widths of webbing held edge to edge with an assembly splice. A wear pad is attached on one or both sides of the sling body and on one or both sides of the loop eyes to form a loop eye at each end which is at a right angle to the plane of the sling body.

(c) **FIG. 7 SYNTHETIC WEBBING SLINGS**



Angle of Choke



Choke Angle (deg)	Choker Hitch - Rated Capacity Adjustment (Percent of Choker Rated Capacity)
121 - 135	100
90 - 120	87
60 - 89	74
30 - 59	62
Up to 29	49

(96)
(c)

FIG. 8 WIRE ROPE SLINGS IN CHOKER HITCH

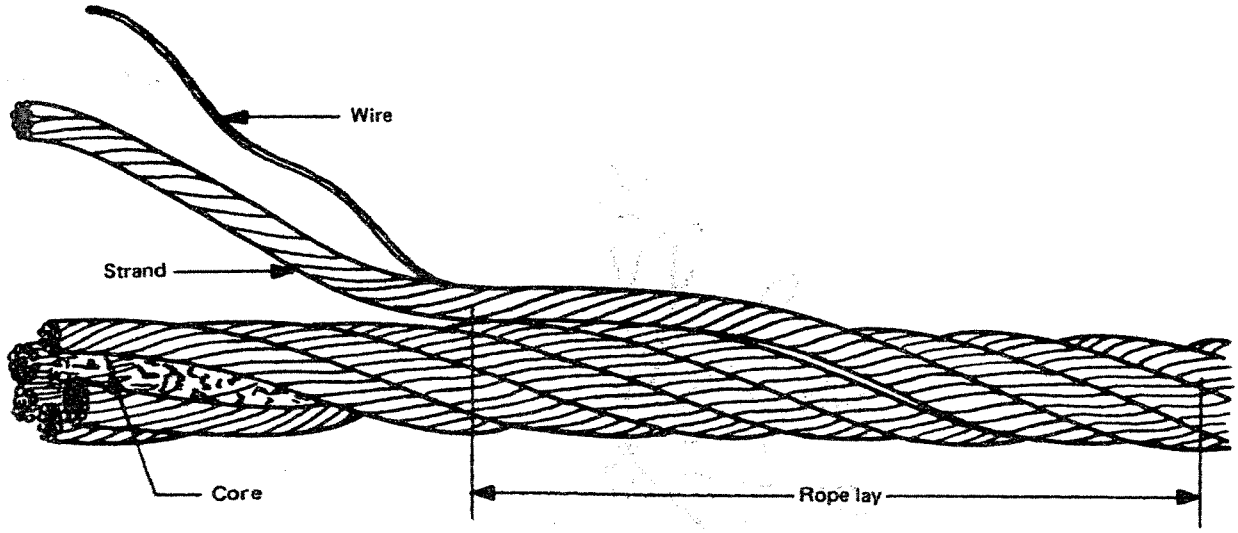
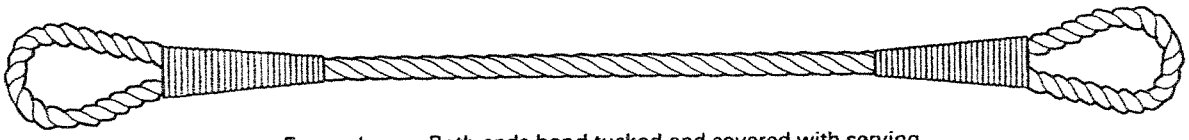
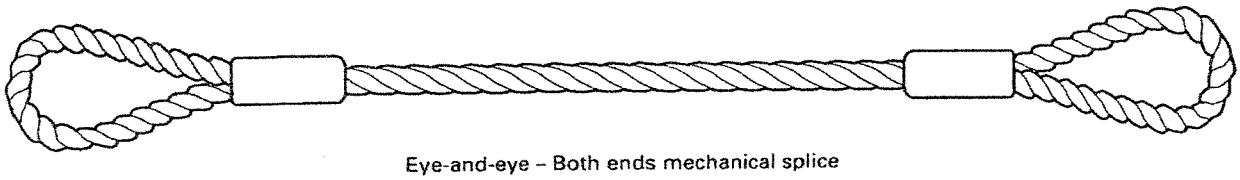


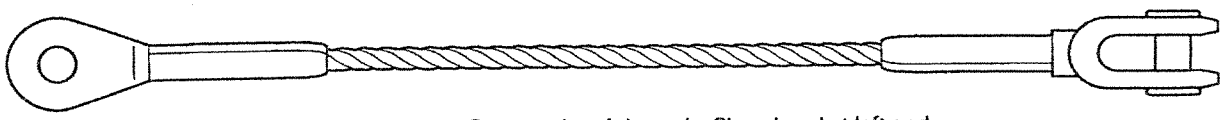
FIG. 9 ELEMENTS OF WIRE ROPE



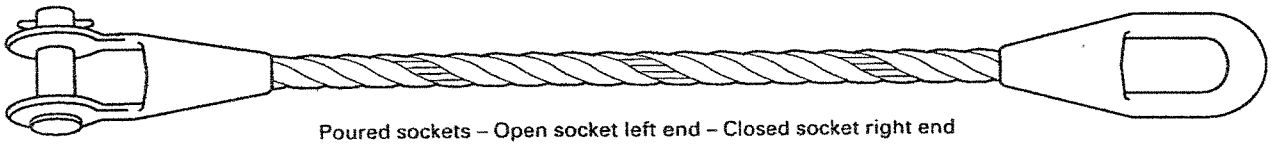
Eye-and-eye – Both ends hand tucked and covered with serving



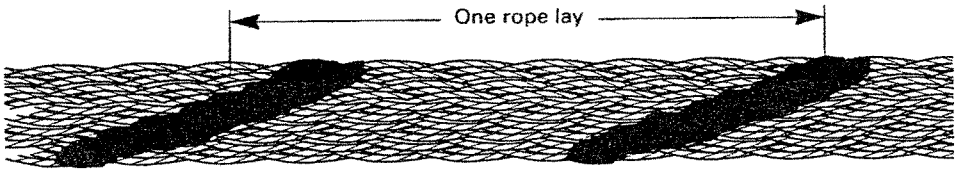
Eye-and-eye – Both ends mechanical splice

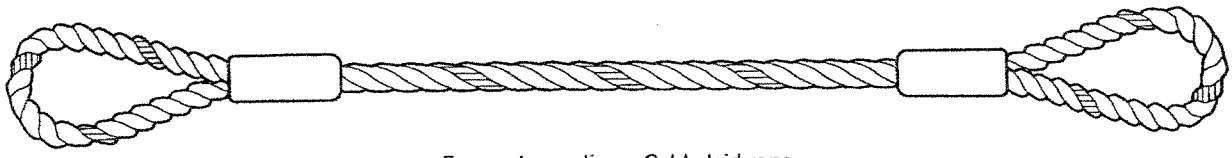


Swaged sockets – Open socket right end – Closed socket left end

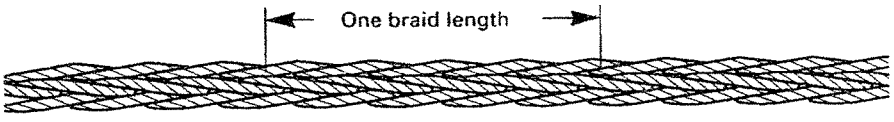


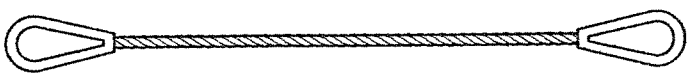
Poured sockets – Open socket left end – Closed socket right end





Eye-and-eye sling – Cable laid rope





Multipart sling

FIG. 10 WIRE ROPE SLINGS

(c)

CHAPTER 9-1
Alloy Steel Chain Slings — Selection, Use, and Maintenance

(96) Section 9-1.0: Scope

This Chapter applies to alloy steel chain slings used for overhead lifting.

(96) Section 9-1.1: Materials and Configurations

(c) **9-1.1.1** Grade 80 alloy steel chain slings shall be made from chain manufactured and tested in accordance with ASTM A 391/A 391M and assembled in accordance with ASTM A 906/A 906M.

9-1.1.2 Grade 100 alloy steel chain slings shall be made from chain manufactured and tested in accordance with ASTM A 973/A 973M.

9-1.1.3 If chain or components other than those described in ASTM A 391/A 391M or ASTM A 973/A 973M, and ASTM A 906/A 906M are used, they shall be rated in accordance with the recommendations of the chain, component, or sling manufacturer. Other grades of proof tested steel chain include Proof Coil (Grade 28), Hi-Test (Grade 43) Chain, and Transport (Grade 70) Chain. These grades are not recommended for overhead lifting and therefore are not covered by this Chapter.

9-1.1.4 Attachments and components used for sling assemblies shall meet the requirements of Section 9-1.7.

9-1.1.5 Single leg, double leg, triple leg, and quadruple leg slings are covered by this volume.

(96) Section 9-1.2: Design Factor

Rated loads for alloy steel chain slings shall be based on a minimum design factor of 4.

(96) Section 9-1.3: Rated Loads

The term *working load limit* is commonly used to describe rated load.

(c) **9-1.3.1** Rated loads for single leg, double leg, triple leg, and quadruple leg alloy steel chain slings shall conform to the values shown in Table 1 for Grade 80 and Table 2 for Grade 100 for the horizontal angles listed.

9-1.3.2 Rated loads for sling angles not listed in Table 1 shall be calculated as follows:

(a) Rated load for double leg slings = 2 × single leg vertical hitch rated load × sine of minimum horizontal angle. (c)

(b) Rated load for triple and quadruple leg slings = 3 × single leg vertical hitch rated load × sine of minimum horizontal angle. (c)

9-1.3.3 The ratings for quadruple leg slings shown in Table 1 and Table 2 are the same as the ratings for triple leg slings because normal lifting practice may not distribute load uniformly on all four legs. (a) (c)

9-1.3.4 Configurations not covered by this Chapter shall be rated in accordance with the recommendation of the sling manufacturer. (a)

Section 9-1.4: Proof Testing

9-1.4.1 Prior to initial use, all welded slings shall be proof tested by the sling manufacturer with written records kept of such testing. (c)

(a) For single or multiple leg slings each leg shall be proof tested to twice the single leg vertical hitch rated load (Table 1 or Table 2).

(b) Master links for double leg slings shall be proof tested to four times the single leg vertical hitch rated load (Table 1 or Table 2).

(c) Master links for triple or quad leg slings shall be proof tested to six times the single leg vertical hitch rated load (Table 1 or Table 2).

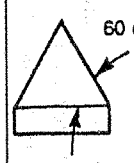
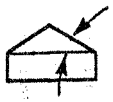
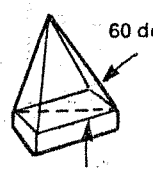
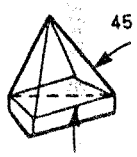
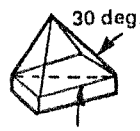
(d) Master coupling links (Fig. 6) for triple or quad slings shall be proof tested to two times the single leg vertical hitch rated load (Table 1 or Table 2) times the number of legs connected to the master coupling link.

9-1.4.2 Mechanically assembled slings shall be comprised entirely of proof tested components. (c)

(a) Leg components for single or multiple leg slings shall be proof tested to twice the single leg vertical hitch rated load (Table 1 or Table 2).

(96)
(c)

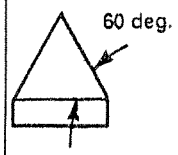
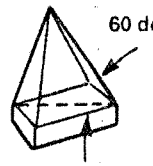
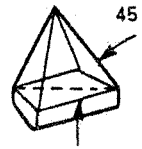
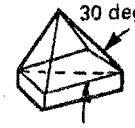
TABLE 1
RATED LOAD FOR GRADE 80 ALLOY STEEL CHAIN SLINGS[1]
(Design Factor = 4)

Chain Size Nominal		Single Leg Vertical Hitch Sling — 90 deg. to Horizontal Loading		Rated Load Double Leg Sling Horizontal Angle [Note (2)]						Triple and Quadruple Leg Sling [Note (3)] Horizontal Angle [Note (2)]					
				 Double at 60 deg.		 Double at 45 deg.		 Double at 30 deg.		 Quad at 60 deg.		 Quad at 45 deg.		 Quad at 30 deg.	
in.	mm	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
7/32	5.5	2,100	950	3,600	1650	3,000	1350	2,100	950	5,500	2500	4,400	2000	3,200	1450
9/32	7	3,500	1600	6,100	2700	4,900	2200	3,500	1600	9,100	4100	7,400	3300	5,200	2400
5/16	8	4,500	2050	7,800	3550	6,400	2900	4,500	2050	11,700	5300	9,500	4300	6,800	3100
3/8	10	7,100	3200	12,300	5500	10,000	4500	7,100	3200	18,400	8300	15,100	6800	10,600	4800
1/2	13	12,000	5400	20,800	9400	17,000	7600	12,000	5400	31,200	14000	25,500	11500	18,000	8100
5/8	16	18,100	8200	31,300	14200	25,600	11600	18,100	8200	47,000	21300	38,400	17400	27,100	12300
3/4	20	28,300	12800	49,000	22300	40,000	18200	28,300	12800	73,500	33500	60,000	27400	42,400	19300
7/8	22	34,200	15500	59,200	27200	48,400	22200	34,200	15500	88,900	40800	72,500	33300	51,300	23500
1	26	47,700	21600	82,600	37900	67,400	31000	47,700	21600	123,900	56900	101,200	46500	71,500	32800
1 1/4	32	72,300	32800	125,200	56800	102,200	46400	72,300	32800	187,800	85200	153,400	69600	108,400	49200

NOTES:
(1) Other grades of proof tested steel chain include Proof Coil (Grade 28), Hi-Test (Grade 43) Chain, and Transport (Grade 70) Chain. These grades are not recommended for overhead lifting and therefore are not covered by this Standard.
(2) Rating of multileg slings adjusted for angle of loading between the inclined leg and the horizontal plane of the load.
(3) Quadruple sling rating is same as triple sling because normal lifting practice may not distribute load uniformly on all four legs.

(c)

TABLE 2
RATED LOAD FOR GRADE 100 ALLOY STEEL CHAIN SLINGS[1]
(Design Factor = 4)

Chain Size Nominal		Single Leg Vertical Hitch Sling — 90 deg. to Horizontal Loading		Rated Load Double Leg Sling Horizontal Angle [Note (2)]						Triple and Quadruple Leg Sling [Note (3)] Horizontal Angle [Note (2)]					
				 Double at 60 deg.		 Double at 45 deg.		 Double at 30 deg.		 Quad at 60 deg.		 Quad at 45 deg.		 Quad at 30 deg.	
in.	mm	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
7/32	5.5	2,700	1200	4,700	2100	3,800	1700	2,700	1200	7,000	3200	5,000	2600	4,000	1800
9/32	7	4,300	1950	7,500	3400	6,100	2700	4,300	1950	11,200	5100	9,100	4100	6,400	2900
5/16	8	5,700	2600	9,900	4500	8,100	3700	5,700	2600	14,800	6700	12,100	5500	8,500	3900
3/8	10	8,800	4000	15,200	6900	12,400	5600	8,800	4000	22,800	10300	18,600	8400	13,200	6000
1/2	13	15,000	6800	26,000	11800	21,200	9600	15,000	6800	39,000	17700	31,800	14400	22,500	10200
5/8	16	22,600	10300	39,100	17700	32,000	14500	22,600	10300	58,700	26600	47,900	21700	33,900	15400
3/4	20	35,300	16000	61,100	27700	49,900	22600	35,300	16000	91,700	41600	74,900	34000	53,000	24000
7/8	22	42,700	19400	74,000	33600	60,400	27400	42,700	19400	110,900	50300	90,600	41100	64,000	29100

NOTES:
(1) Other grades of proof tested steel chain include Proof Coil (Grade 28), Hi-Test (Grade 43) Chain, and Transport (Grade 70) Chain. These grades are not recommended for overhead lifting and therefore are not covered by this Standard.
(2) Rating of multileg slings adjusted for angle of loading between the inclined leg and the horizontal plane of the load.
(3) Quadruple sling rating is same as triple sling because normal lifting practice may not distribute load uniformly on all four legs.

(b) Master links and master coupling links shall be proof tested per paras. 9-1.4.1(b), (c), and (d).

(c) If untested components are employed, the sling shall be proof tested per para. 9-1.4.1 prior to initial use.

9-1.4.3 All repaired or reconditioned slings requiring heat treating or welding shall be proof tested per para. 9-1.4.1 prior to being returned to service. Slings repaired or reconditioned using mechanically assembled components shall be subjected to the provisions of para. 9-1.4.2.

(96) (a) (c) **Section 9-1.5: Sling Identification**

9-1.5.1 Marking Requirements. Each sling shall be marked to show:

(a) name or trademark of manufacturer
(b) grade and size
(c) number of legs
(d) rated loads for the hitches used
(e) reach

9-1.5.2 Sling identification shall be done by the sling manufacturer.

9-1.5.3 Maintenance of Sling Identification. Sling identification should be maintained by the user so as to be legible during the life of the sling.

Section 9-1.6: Effects of Environment

(c) **9-1.6.1** When the chain sling becomes heated to a temperature in excess of 600°F (316°C) for Grade 80 or 400°F (205°C) for Grade 100, rated loads shall be reduced in accordance with the chain manufacturer's recommendations regarding usage both while heated and after being heated. The chain manufacturer should be consulted when chain slings are to be used in temperatures below −40°F (−40°C) for Grade 80 or −20°F (−29°C) for Grade 100.

9-1.6.2 The strength of slings can be affected by chemically active environments as sling materials may be susceptible to damage from caustic or acid substances or fumes; strongly oxidizing environments attack all common sling materials. The sling manufacturer should therefore be consulted before slings are used in chemically active environments.

Section 9-1.7: Attachments

9-1.7.1 Hooks, rings, oblong links, pear-shaped links, welded or mechanical coupling links or other sling attachments or components shall have a rated load at least equal to that of alloy steel chain with which they are used. In special cases where particular use makes this impractical, the sling shall be identified with a rated load consistent with the lowest working load rating of any of the attachments or components.

9-1.7.2 Attachments should be of a size recommended by the sling manufacturer.

9-1.7.3 Makeshift fasteners, hooks, or links formed from bolts, rods, etc., or other such components shall not be used. Special attachments designed by a qualified person may be used.

9-1.7.4 Where used, handles shall be welded to the master link or hook prior to heat treating.

9-1.7.5 Hook characteristics shall meet the requirements of ASME B30.10.

Section 9-1.8: Inspection and Repairs

9-1.8.1 Inspection Classification

(a) Initial Inspection. Prior to use, all new, altered, modified, or repaired slings shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter. (96)

(b) Inspection procedure for chain slings in regular service is divided into two general classifications based upon the interval at which inspection should be performed. The intervals in turn are dependent upon the degree of exposure of the sling components to wear and deterioration. The two general classifications are herein designated as *frequent* and *periodic*, with respective intervals between inspections as defined below.

(1) Frequent Inspection. Visual examinations by the user or other designated personnel with records not required.

(a) Normal service — monthly
(b) Severe service — daily to weekly
(c) Special or infrequent service — as recommended by a qualified person before and after each occurrence

(2) Periodic Inspection. Visual inspection by a designated person making a record of the inspection or of apparent conditions to provide the basis for a continuing evaluation.

(a) Normal service — yearly
(b) Severe service — monthly to quarterly

(c) Special or infrequent service — as recommended by a qualified person before the first such occurrence and as directed by the qualified person for any subsequent occurrences

9-1.8.2 Frequent Inspection. Slings shall be inspected for damage at intervals as defined in para. 9-1.8.1(b)(1). In addition, visual observations should be conducted during regular service for any damage or evidence of malfunction that appears between regular inspections. Any deficiencies such as listed shall cause the sling to be set aside for periodic inspection.

(a) Chain and attachments for wear, nicks, cracks, breaks, gouges, stretch, bends, weld splatter, discoloration from excessive temperature, and throat opening of hooks.

(1) Chain links and attachments should hinge freely with adjacent links.

(2) Latches on hook, if present, should hinge freely and seat properly without evidence of permanent distortion.

(b) Missing or illegible sling identification as defined in Section 9-1.5.

9-1.8.3 Periodic Inspection. Complete link by link inspections of the slings shall be performed at intervals as defined in para. 9-1.8.1(b)(2). Any deficiencies, such as listed, shall be examined and determination made as to whether they constitute a hazard. These inspections shall include the requirements of para. 9-1.8.2 and, in addition, items such as the following.

(a) Each link and each attachment shall be examined individually, taking care to expose inner link surfaces of the chain and chain attachments to inspect for those items defined in para. 9-1.8.2.

(a) (c) *(1)* Worn links shall not exceed values given in Table 3 or that which is specifically recommended by the manufacturer.

(c) *(2)* Sharp transverse nicks and gouges should be rounded out by grinding and the depth of the gouge or rounded out portion should not exceed values given in Table 3.

(3) Hooks should be inspected in accordance with ASME B30.10.

(4) If present, latches on hooks should seat properly, rotate freely, and show no permanent distortion.

9-1.8.4 Repairs

(a) Any hazardous condition disclosed by the inspection requirements of para. 9-1.8.1 shall be corrected before use of the chain or sling is resumed.

TABLE 3 (c)
MAXIMUM ALLOWABLE WEAR AT ANY POINT OF LINK

Nominal Chain or Coupling Link Size		Maximum Allowable Thickness at Any Point on the Link	
in.	mm	in.	mm
7/32	5.5	0.189	4.80
9/32	7	0.239	6.07
5/16	8	0.273	6.93
3/8	10	0.342	8.69
1/2	13	0.443	11.26
5/8	16	0.546	13.87
3/4	20	0.687	17.45
7/8	22	0.750	19.05
1	26	0.887	22.53
1 1/4	32	1.091	27.71

GENERAL NOTE: For other sizes, consult chain or sling manufacturer.

(b) Repairs shall be made only by the chain manufacturer or qualified personnel.

(c) When repairs are made, the following criteria shall be followed.

(1) Alloy steel chain and coupling links used for repair shall conform to the strength requirements and other requirements of this Standard. Cracked, broken, or bent links shall not be repaired; they shall be replaced.

(2) When repaired, a sling shall be permanently marked to identify the repairing agency.

(3) Attachments which are used for repair shall conform to the strength requirements and other requirements of this Standard. Cracked, broken, or bent attachments shall not be repaired; they shall be replaced.

(4) Mechanical coupling links or carbon steel repair links shall not be used to repair broken lengths of alloy chain.

Section 9-1.9: Operating Practices

(a) Slings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with Table 1 or Table 2 and the requirements of Section 9-1.6. (c)

(b) The weight of load shall be within the rated load of the sling.

(c) Slings shall be shortened or otherwise adjusted only by methods approved by the sling manufacturer or a qualified person. (c)

(d) Slings shall not be shortened or lengthened by knotting or twisting.

(e) Slings that appear to be damaged shall not be used unless inspected and accepted as usable under Section 9-1.8.

(f) The sling shall be hitched or rigged in a manner providing control of the load.

(g) Sharp corners in contact with the sling should be padded with material of sufficient strength to minimize damage to the sling.

(c) *(h)* All portions of the human body shall be kept from between the sling and the load and from between the sling and the crane hook or hoist hook.

(i) Personnel should stand clear of the suspended load.

(j) Personnel shall not ride the sling.

(k) Shock loading should be avoided.

(l) Slings should not be pulled from under a load when the load is resting on the sling.

(m) Slings should be stored in an area where they will not be subjected to mechanical damage, corrosive action, moisture, extreme heat, or kinking.

(n) Twisting and kinking the legs shall be avoided.

(o) The load applied to the hook should be centered in the base (bowl) of hooks to prevent point loading on the hook, unless the hook is designed for point loading.

(p) During lifting, with or without load, personnel shall be alert for possible snagging.

(q) In a basket hitch, the load should be balanced to prevent slippage.

(r) The sling's legs should contain or support the load so that the load remains under control.

(s) Multiple leg slings shall be selected according to Table 1 or Table 2 when used at the specific angles given in the table. Operation at other angles shall be limited to rated loads of the next lower angle given in the table or calculated trigonometrically [see para. 9-2.3(d)] so as to not introduce into the leg itself a load in direct tension greater than that permitted. (c)

(t) Slings should be long enough so that the rated load is adequate when the angle of the legs is taken into consideration (see Table 1 or Table 2). (c)

(u) Slings should not be dragged on the floor or over an abrasive surface.

(v) When used in a choker hitch arrangement, slings shall be selected to prevent the load developed on any portion of the sling from exceeding the rated load of the sling components.

(w) For multiple leg slings used with non-symmetrical loads, an analysis by a qualified person should be performed to prevent overloading of any leg. (96)

(x) If extreme temperatures are involved, the guidance provided in para. 9-1.6.1 shall be followed. (c)

CHAPTER 9-2
Wire Rope Slings — Selection, Use, and Maintenance

Section 9-2.0: Scope

This Chapter applies to slings made of wire rope.

Section 9-2.1: Construction

(c) **9-2.1.1 Wire Rope Material.** The wire rope slings covered by this Chapter shall be as specified in Tables 4 through 11 based upon nominal wire rope strength as shown in Federal Specification RR-W-410 and Military Specification MIL-W-83420 (except for fatigue requirements which are not applicable to sling usage). Grades, types, sizes, and constructions other than those specified in Tables 4 through 11 may be used. When such slings are used, the sling manufacturer shall be consulted for specific data.

9-2.1.2 Minimum Sling Length

(a) Slings made of rope with 6 × 19 and 6 × 37 classification, and cable laid slings shall have a minimum clear length of rope 10 times the rope diameter between splices, sleeves, or end fittings.

(b) Braided slings shall have a minimum clear length of rope 40 times the component (individual) rope diameter between the loops or end fittings.

(c) Grommets and endless slings shall have a minimum circumferential length of 96 times the body diameter of the grommet or endless sling.

Section 9-2.2: Design Factor

The design factor for wire rope slings shall be a minimum of 5.

(96) (c) Section 9-2.3: Rated Load

The term *rated capacity* is commonly used to describe rated load.

Rated load for wire rope slings shall be as shown in Tables 4 through 11. These rated loads are based on the following factors:

(a) nominal wire rope strength

(b) nominal splicing or end attachment efficiency

(c) design factor for wire rope slings shall be a minimum of 5

(d) Tables 4 through 11 show rated loads for single leg slings. For rated loads for bridle slings, for basket hitches where both legs are not vertical, and for consideration of the angle between basket hitch slings (see Fig. 11), the following equation shall be applicable:

rated load = single leg sling vertical hitch rated load[1] × number of legs × sine of minimum horizontal angle

Sines
30 deg. — 0.500
45 deg. — 0.707
60 deg. — 0.866

(e) Horizontal sling angles less than 30 deg. should not be used.

(f) type of hitch, e.g., vertical, choker or basket

(g) angle of loading

(h) diameter of curvature around which sling is bent

(i) When a sling is used in a choker hitch, the normal angle formed in the rope body as it passes through the choking eye is 120 deg. or greater. Rated loads in Tables 4 through 11 are for angles of 120 deg. or greater. For smaller angles, the rated load shall be reduced to the percentages of the table values given in Fig. 8.

Section 9-2.4: Proof Test (a)

9-2.4.1 All swaged-socket and poured-socket assemblies shall be proof tested to the wire rope or fitting manufacturers recommendations but in no case greater than 50% of the component wire ropes' or structural strands' nominal strength. All other assemblies shall be proof tested when specified by the purchaser. The proof load for swaged-socket and poured-socket assemblies shall be a minimum of two times the vertical hitch rated load but shall not exceed 2.5 times the vertical hitch rated load. (c)

[1] Tables 4 through 11. (c)

(c)

TABLE 4
RATED LOADS FOR SINGLE LEG SLINGS 6 x 19 or 6 x 37 (6 x 36) CLASSIFICATION IMPROVED PLOW STEEL GRADE ROPE WITH FIBER CORE (FC)
(Design Factor = 5)

Rope Diameter, in.	Rated Loads [Note (1)], Tons (2000 lb)					
	Vertical Hitch			Choker Hitch	Vertical Basket Hitch [Note (2)]	Vertical Basket Hitch [Note (3)]
	HT	MS	S	HT & MS	HT	MS & S
1/4	0.49	0.51	0.55	0.38	0.99	1.0
5/16	0.76	0.79	0.85	0.6	1.5	1.6
3/8	1.1	1.1	1.2	0.85	2.1	2.2
7/16	1.4	1.5	1.7	1.2	2.9	3.0
1/2	1.8	2.0	2.1	1.5	3.7	4.0
9/16	2.3	2.5	2.7	1.9	4.6	5.0
5/8	2.8	3.1	3.3	2.3	5.6	6.2
3/4	3.9	4.4	4.8	3.3	7.8	8.8
7/8	5.2	6.0	6.4	4.5	10	12
1	6.7	7.7	8.4	5.9	13	15
1 1/8	8.4	9.5	11	7.4	17	19
1 1/4	10	12	13	9.0	21	24
1 3/8	12	14	16	11	24	28
1 1/2	15	17	18	13	29	34
1 5/8	17	19	21	15	34	38
1 3/4	20	22	25	17	40	44
2	26	29	32	22	51	58

HT = Hand Tucked Splice
MS = Mechanical Splice
S = Poured Socket or Swaged Socket

NOTES:
(1) These values are based on slings being vertical. If they are not vertical, the rated load shall be reduced. If two or more slings are used, the minimum horizontal angle between the slings shall also be considered [see para. 9-2.3(d)].
(2) These values only apply when the D/d ratio (see Fig. 12) is 15 or greater.
(3) These values only apply when the D/d ratio (see Fig. 12) is 25 or greater.
D = Diameter of curvature around which the body of the sling is bent
d = Diameter of rope

(c)

TABLE 5
RATED LOADS FOR SINGLE LEG SLINGS 6 x 19 or 6 x 37 (6 x 36) CLASSIFICATION IMPROVED PLOW STEEL GRADE ROPE WITH INDEPENDENT WIRE ROPE CORE (IWRC)
(Design Factor = 5)

Rope Diameter, in.	Rated Loads [Note (1)], Tons (2000 lb)					
	Vertical Hitch			Choker Hitch	Vertical Basket Hitch [Note (2)]	Vertical Basket Hitch [Note (3)]
	HT	MS	S	HT & MS	HT	MS & S
1/4	0.53	0.56	0.59	0.41	1.1	1.1
5/16	0.82	0.87	0.92	0.64	1.6	1.7
3/8	1.2	1.2	1.3	0.92	2.3	2.5
7/16	1.5	1.7	1.8	1.2	3.1	3.4
1/2	2.0	2.2	2.3	1.6	4.0	4.4
9/16	2.5	2.8	2.9	2.0	4.9	5.5
5/8	3.0	3.4	3.6	2.5	6.0	6.8
3/4	4.2	4.9	5.1	3.6	8.4	9.7
7/8	5.5	6.6	6.9	4.8	11	13
1	7.2	8.5	9.0	6.3	14	17
1 1/8	9.0	10	11	7.9	18	20
1 1/4	11	13	14	9.7	22	26
1 3/8	13	15	17	12	27	31
1 1/2	16	18	20	14	32	37
1 5/8	18	21	23	16	37	43
1 3/4	21	25	27	19	43	49
2	28	32	34	24	55	64

HT = Hand Tucked Splice
For Hidden Tuck Splice (IWRC), use values in HT columns of Table 4
MS = Mechanical Splice
S = Poured Socket or Swaged Socket

NOTES:
(1) These values are based on slings being vertical. If they are not vertical, the rated load shall be reduced. If two or more slings are used, the minimum horizontal angle between the slings shall also be considered [see para. 9-2.3(d)].
(2) These values only apply when the *D/d* ratio (see Fig. 12) is 15 or greater.
(3) These values only apply when the *D/d* ratio (see Fig. 12) is 25 or greater.
D = Diameter of curvature around which the body of the sling is bent.
d = Diameter of rope

(c)

TABLE 6
RATED LOADS FOR SINGLE LEG SLINGS 6 x 19 or 6 x 37 (6 x 36) CLASSIFICATION EXTRA IMPROVED PLOW STEEL GRADE ROPE WITH INDEPENDENT WIRE ROPE CORE (IWRC)
(Design Factor = 5)

Rope Diameter, in.	Rated Loads [Note (1)], Tons (2000 lb)			
	Vertical Hitch		Choker Hitch	Vertical Basket Hitch [Note (2)]
	MS	S	MS & S	MS & S
1/4	0.65	0.68	0.48	1.3
5/16	1.0	1.1	0.74	2.0
3/8	1.4	1.5	1.1	2.9
7/16	1.9	2.0	1.4	3.9
1/2	2.5	2.7	1.9	5.1
9/16	3.2	3.4	2.4	6.4
5/8	3.9	4.1	2.9	7.8
3/4	5.6	5.9	4.1	11
7/8	7.6	8.0	5.6	15
1	9.8	10	7.2	20
1 1/8	12	13	9.1	24
1 1/4	15	16	11	30
1 3/8	18	19	13	36
1 1/2	21	23	16	42
1 5/8	24	26	18	49
1 3/4	28	31	21	57
2	37	40	28	73

MS = Mechanical Splice
S = Poured Socket or Swaged Socket

NOTES:
(1) These values are based on slings being vertical. If they are not vertical, the rated load shall be reduced. If two or more slings are used, the minimum horizontal angle between the slings shall also be considered [see para. 9-2.3(d)].
(2) These values only apply when the D/d ratio (see Fig. 12) is 25 or greater.
D = Diameter of curvature around which the body of the sling is bent
d = Diameter of rope

(c)

TABLE 7
RATED LOADS FOR SINGLE LEG SLINGS 6 x 19 AND 6 x 37 (6 x 36) CLASSIFICATION EXTRA EXTRA IMPROVED PLOW STEEL GRADE ROPE WITH INDEPENDENT WIRE ROPE CORE (IWRC)
(Design Factor = 5)

Rope Diameter, in.	Rated Loads [Note (1)], Tons (2000 lb)								
	Vertical Hitch			Choker Hitch			Vertical Basket Hitch [Note (2)]		
	HT	MS	S	HT	MS	S	HT	MS	S
1/4	0.60	0.71	0.74	0.46	0.52	0.52	1.2	1.4	1.5
5/16	0.92	1.1	1.2	0.72	0.81	0.81	1.8	2.2	2.3
3/8	1.3	1.6	1.7	1.0	1.2	1.2	2.6	3.2	3.3
7/16	1.7	2.1	2.2	1.4	1.6	1.6	3.5	4.3	4.5
1/2	2.2	2.8	2.9	1.8	2.0	2.0	4.5	5.5	5.8
9/16	2.8	3.5	3.7	2.3	2.6	2.6	5.6	7.0	7.4
5/8	3.4	4.3	4.5	2.8	3.2	3.2	6.8	8.6	9.1
3/4	4.7	6.2	6.5	4.0	4.5	4.5	9.4	12	13
7/8	6.2	8.3	8.8	5.5	6.1	6.1	12	17	18
1	8.1	11	11	7.1	8.0	8.0	16	22	23
1 1/8	...	...	14	...	...	10	...	...	29
1 1/4	...	...	18	...	...	12	...	...	35
1 3/8	...	...	21	...	...	15	...	...	42
1 1/2	...	...	25	...	...	18	...	...	50
1 5/8	...	...	29	...	...	20	...	...	58
1 3/4	...	...	34	...	...	24	...	...	68
1 7/8	...	...	38	...	...	27	...	...	77
2	...	...	43	...	...	30	...	...	87

HT = Hand Tucked Splice
MS = Mechanical Splice
S = Poured Socket or Swaged Socket

NOTES:
(1) These values are based on slings being vertical. If they are not vertical, the rated load shall be reduced. If two or more slings are used, the minimum horizontal angle between the slings shall also be considered [see para. 9-2.3(d)].
(2) These values only apply when the D/d ratio (see Fig. 12) is 20 or greater.
D = Diameter of curvature around which the body of the sling is bent.
d = Diameter of component rope.

TABLE 8 (c)
RATED LOADS FOR SINGLE LEG SLINGS CABLE LAID ROPE — MECHANICAL SPLICE ONLY 7 x 7 x 7 or 7 x 7 x 19 CONSTRUCTION GALVANIZED AIRCRAFT GRADE ROPE 7 x 6 x 19 (IWRC) OR 7 x 6 x 37 (7 x 6 x 36) (IWRC) CLASSIFICATION IMPROVED PLOW STEEL GRADE ROPE
(Design Factor = 5)

	Rated Loads [Note (1)], Tons (2000 lb)		
Rope Diameter, in.	Vertical Hitch	Choker Hitch	Vertical Basket Hitch [Note (2)]
	7 x 7 x 7 CONSTRUCTION		
1/4	0.50	0.34	1.0
3/8	1.1	0.74	2.2
1/2	1.9	1.3	3.7
5/8	2.8	1.9	5.5
3/4	3.8	2.6	7.6
	7 x 7 x 19 CONSTRUCTION		
5/8	2.9	2.0	5.8
3/4	4.1	2.8	8.1
7/8	5.4	3.7	11
1	6.9	4.7	14
1 1/8	8.3	5.8	17
1 1/4	9.9	7.0	20
	7 x 6 x 19 IWRC or 7 x 6 x 37 (7 x 6 x 36) IWRC CLASSIFICATIONS		
3/4	3.8	2.8	7.6
7/8	5.0	3.4	10
1	6.4	4.4	13
1 1/8	7.7	5.4	15
1 1/4	9.3	6.5	19
1 5/16	10	7.0	20
1 3/8	11	7.7	22
1 1/2	13	9.0	26

NOTES:
(1) These values are based on slings being vertical. If they are not vertical, the rated load shall be reduced. If two or more slings are used, the minimum horizontal angle between the slings shall also be considered [see para. 9-2.3(d)].
(2) These values only apply when the D/d ratio (see Fig. 12) is 10 or greater.
D = Diameter of curvature around which the body of the sling is bent
d = Diameter of rope

(c)

TABLE 9
RATED LOADS FOR SINGLE LEG SLINGS 8-PART OR 6-PART BRAIDED ROPE 6 x 19 OR 6 x 37 (6 x 36) CLASSIFICATION IMPROVED PLOW STEEL ROPE FIBER CORE (FC) (Design Factor = 5)

Component Rope Diameter, in.	Rated Loads [Note (1)], Tons (2000 lb)					
	Vertical Hitch		Choker Hitch		Vertical Basket Hitch [Note (2)]	Vertical Basket Hitch [Note (3)]
	8 Part	6 Part	8 Part	6 Part	8 Part	6 Part
	6 x 19 or 6 x 37 CLASSIFICATIONS					
3/16	1.7	1.3	1.5	1.1	3.5	2.6
1/4	3.1	2.3	2.7	2.0	6.1	4.6
5/16	4.8	3.6	4.2	3.1	9.5	7.2
3/8	6.8	5.1	6.0	4.5	14	10
7/16	9.3	6.9	8.1	6.1	19	14
1/2	12	9.0	10	7.9	24	18
9/16	15	11	13	9.9	30	23
5/8	19	14	16	12	37	28
3/4	27	20	23	18	53	40
7/8	36	27	32	24	72	54
1	47	35	41	31	94	70
1 1/8	59	44	52	39	118	88

NOTES:
(1) These values are based on slings being vertical. If they are not vertical, the rated load shall be reduced. If two or more slings are used, the minimum horizontal angle between the slings shall also be considered [see para. 9-2.3(d)].
(2) These values only apply when the *D/d* ratio (see Fig. 12) is 20 or greater.
D = Diameter of curvature around which the body of the sling is bent
d = Diameter of component rope
(3) These values only apply when the *D/d* ratio (see Fig. 12) is 25 or greater.

(c) **9-2.4.2** The proof load for single leg hand tucked slings shall be a minimum of the vertical hitch rated load and shall not exceed 1.25 times the vertical hitch rated load.

(c) **9-2.4.3** The proof load for mechanical splice single leg slings and endless slings shall be two times the vertical hitch rated load.

(c) **9-2.4.4** The proof load for multiple leg bridle slings shall be applied to the individual legs and shall be either 1.25, for hand tucked splice, or 2, for mechanical splice, times the vertical hitch rated load of a single leg sling of the same size, grade, and construction of rope. Any master link to which multiple leg slings are connected shall be proof loaded to two times the force applied by the combined legs.

(c) ### Section 9-2.5: Sling Identification

9-2.5.1 Marking Requirements. Each sling shall be marked to show:
(a) name or trademark of manufacturer
(b) rated load for the type of hitch(es), and the angle upon which it is based
(c) diameter or size

9-2.5.2 Sling identification shall be done by the sling manufacturer.

9-2.5.3 Maintenance of Sling Identification. Sling identification should be maintained by the user so as to be legible during the life of the sling.

Section 9-2.6: Effects of Environment

9-2.6.1 Fiber core wire rope slings of all grades shall not be exposed to temperatures in excess of 180°F (82°C).

9-2.6.2 When wire rope slings of any grade are to be used at temperatures above 400°F (204°C) or below −60°F (−51°C), the sling manufacturer should be consulted.

TABLE 10 (c)
RATED LOADS FOR SINGLE LEG SLINGS 8-PART OR 6-PART BRAIDED ROPE 6 x 19 OR 6 x 37 (6 x 36) CLASSIFICATION IMPROVED PLOW STEEL GRADE ROPE WITH INDEPENDENT WIRE ROPE CORE (IWRC) 7 x 7 CLASSIFICATION GALVANIZED AIRCRAFT GRADE ROPE (Design Factor = 5)

Component Rope Diameter, in.	Rated Loads [Note (1)], Tons (2000 lb)					
	Vertical Hitch		Choker Hitch		Vertical Basket Hitch [Note (2)]	Vertical Basket Hitch [Note (3)]
	8 Part	6 Part	8 Part	6 Part	8 Part	6 Part
	7 x 7 CLASSIFICATION					
3/32	0.52	0.39	0.46	0.34	1.04	0.78
1/8	0.95	0.71	0.83	0.62	1.9	1.42
3/16	2.1	1.6	1.8	1.4	4.2	3.2
	6 x 19 IWRC OR 6 x 37 (6 x 36) IWRC CLASSIFICATIONS					
3/16	1.9	1.4	1.7	1.2	3.8	2.8
1/4	3.3	2.5	2.9	2.2	6.6	4.9
5/16	5.1	3.8	4.5	3.4	10	7.6
3/8	7.3	5.5	6.4	4.8	15	11
7/16	10	7.5	8.8	6.6	20	15
1/2	13	9.7	11	8.5	26	19
9/16	16	12	14	11	32	24
5/8	20	15	18	13	40	30
3/4	29	22	25	19	57	43
7/8	39	29	34	25	78	58
1	50	38	44	33	101	75
1 1/8	63	47	55	42	127	95
1 1/4	78	58	68	51	156	116
1 3/8	94	70	82	61	187	140
1 1/2	111	83	97	73	222	166
1 5/8	129	97	113	85	258	193
1 3/4	149	112	130	98	298	223
1 7/8	170	128	149	112	340	255
2	193	144	169	126	385	289

NOTES:
(1) These values are based on slings being vertical. If they are not vertical, the rated load shall be reduced. If two or more slings are used, the minimum horizontal angle between the slings shall also be considered [see para. 9-2.3(d)].
(2) These values only apply when the *D/d* ratio (see Fig. 12) is 20 or greater.
D = Diameter of curvature around which the body of the sling is bent
d = Diameter of component rope
(3) These values only apply when the *D/d* ratio (see Fig. 12) is 25 or greater.

(c)

TABLE 11
RATED LOADS FOR SINGLE LEG SLINGS 8-PART OR 6-PART BRAIDED ROPE 6 x 19 OR 6 x 37 (6 x 36) CLASSIFICATION EXTRA IMPROVED PLOW STEEL GRADE ROPE WITH INDEPENDENT WIRE ROPE CORE (IWRC) (Design Factor = 5)

	Rated Loads [Note (1)], Tons (2000 lb)					
Component Rope Diameter, in.	Vertical Hitch		Choker Hitch		Vertical Basket Hitch [Note (2)]	Vertical Basket Hitch [Note (3)]
	8 Part	6 Part	8 Part	6 Part	8 Part	6 Part
3/16	2.2	1.6	1.9	1.4	4.3	3.2
1/4	3.8	2.9	3.3	2.5	7.6	5.7
5/16	5.9	4.4	5.2	3.9	12	8.8
3/8	8.5	6.3	7.4	5.5	17	13
7/16	11	8.6	10	7.5	23	17
1/2	15	11	13	9	30	22
9/16	19	14	16	12	38	28
5/8	23	17	20	15	46	35
3/4	33	25	29	22	66	49
7/8	45	33	39	29	89	67
1	58	43	51	38	116	87
1 1/8	73	55	64	48	146	109
1 1/4	89	67	78	59	179	134
1 3/8	108	81	94	71	215	161
1 1/2	127	96	111	84	255	191
1 5/8	148	111	130	97	296	222
3/4	171	128	150	112	343	257
1 7/8	195	146	171	128	390	292
2	222	166	194	145	443	332

NOTES:
(1) These values are based on slings being vertical. If they are not vertical, the rated load shall be reduced. If two or more slings are used, the greatest vertical angle between the slings shall also be considered [see para. 9-2.3(d)].
(2) These values only apply when the *D/d* ratio (see Fig. 12) is 20 or greater.
D = Diameter of curvature around which the body of the sling is bent
d = Diameter of component rope
(3) These values only apply when the *D/d* ratio (see Fig. 12) is 25 or greater.

9-2.6.3 The strength of slings can be affected by chemically active environments as sling materials may be susceptible to damage from caustic or acid substances or fumes; strongly oxidizing environments attack all common sling materials. The sling manufacturer should therefore be consulted before slings are used in chemically active environments.

Section 9-2.7: End Attachments

9-2.7.1 All load bearing components welded prior to or after assembly in the sling shall be proof tested.

9-2.7.2 Welding of handles or any other accessories to end attachments, except covers to thimbles, shall be performed prior to the assembly of the sling.

9-2.7.3 Knots. Eyes in wire rope slings shall not be formed using knots.

9-2.7.4 Wire Rope Clips and Hooks

9-2.7.4.1 Wire rope clips shall not be used to fabricate wire rope slings except where the application of slings prevents the use of prefabricated slings or where the specific application is designed by a qualified person.

9-2.7.4.2 Slings made with wire rope clips should not be used as a choker hitch.

9-2.7.4.3 Wire rope clips shall be drop-forged steel of the single saddle (U-bolt) or double saddle type clip. Malleable cast iron clips shall not be used. For spacing, number of clips, and torque values, refer to the clip manufacturer's recommendation. Wire rope

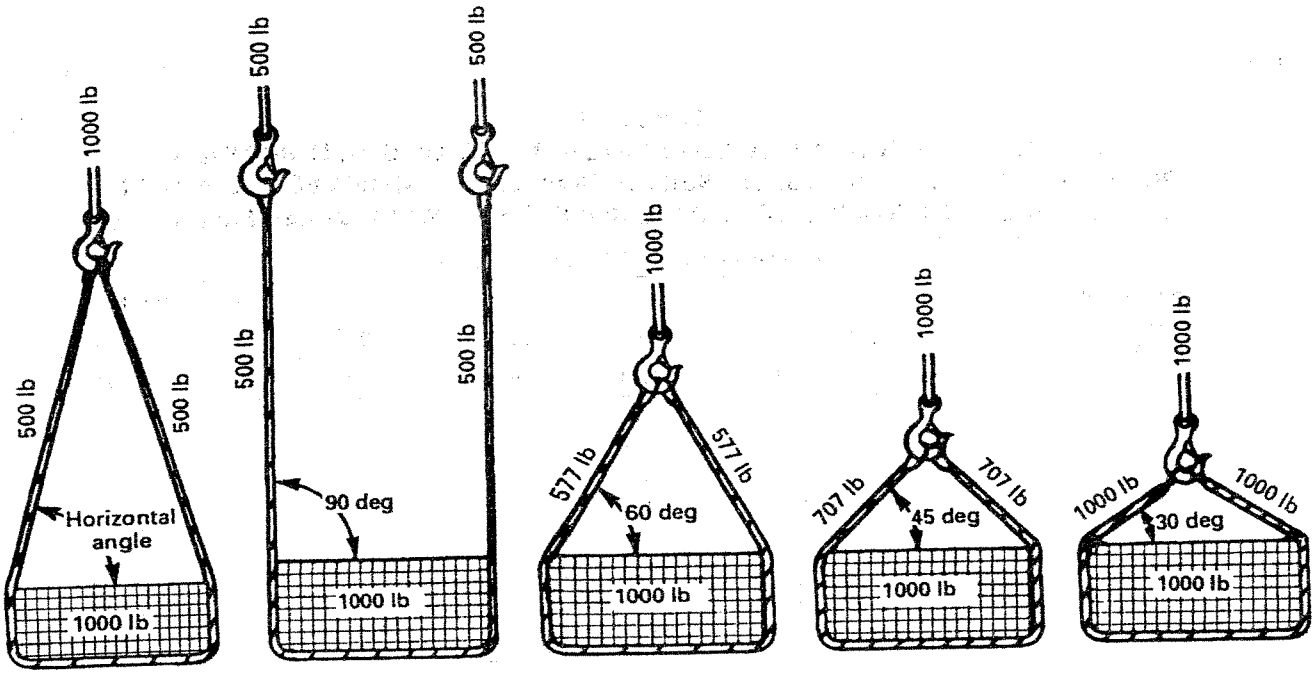


FIG. 11 SLING ANGLES
(Courtesy Wire Rope Technical Board Wire Rope Sling Users Manual)

(c)

clips attached with U-bolts shall have the U-bolt over the dead end of the rope and the live rope resting in the clip saddle. Clips shall be tightened evenly to the recommended torque. After the initial load is applied to the rope, the clip nuts shall be retightened to the recommended torque to compensate for any decrease in rope diameter caused by the load. Rope clip nuts should be retightened periodically to compensate for any further decrease in rope diameter during usage.

9-2.7.4.4 Hook characteristics shall meet the requirements of ASME B30.10.

Section 9-2.8: Sling Inspection and Replacement

9-2.8.1 Frequent Inspection. All slings shall be visually inspected by the person handling the sling each day they are used. These visual observations should be concerned with discovering gross damage, such as listed below, which may be an immediate hazard:

(a) distortion of rope in the sling such as kinking, crushing, unstranding, birdcaging, main strand displacement, or core protrusion. Loss of rope diameter in short rope lengths or unevenness of outer strands should provide evidence the sling or slings should be replaced.

(b) general corrosion;

(c) broken or cut strands;

(d) number, distribution, and type of visible broken wires

See paras. 9-2.8.3(b)(1) and (8) for further guidance.

9-2.8.2 Periodic Inspection. A periodic inspection shall be performed by a designated person on a regular basis with frequency of inspection based on:

(a) frequency of sling use;

(b) severity of service conditions;

(c) nature of lifts being made;

(d) experience gained on the service life of slings used in similar circumstances.

Inspection shall be made at least annually and shall include a record of the inspection or of apparent conditions to provide the basis for a continuing evaluation. Inspection shall be conducted on the entire length of each sling including splices, end attachments, and fittings. Deterioration which would result in loss of original strength shall be observed and determination made whether further use of the sling would constitute a hazard. Para. 9-2.8.3 (Replacement) can provide guidance in making such a determination.

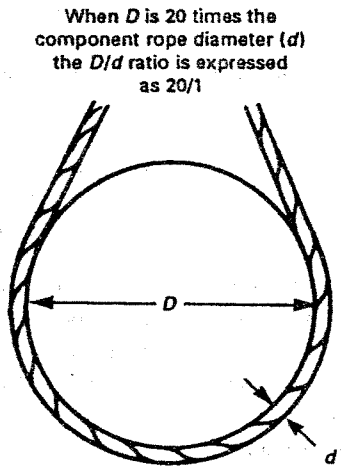


FIG. 12 *D/d* RATIO
(Courtesy Wire Rope Technical Board Wire Rope Sling Users Manual)

(c)

9-2.8.3 Replacement

(96) *(a)* No precise rules can be given for determination of the exact time for sling replacement, since many variable factors are involved. Once a sling reaches a specified removal criteria, it may be allowed to operate to the end of the work shift, based on the judgement of a qualified person. The sling shall be replaced after that work shift, at the end of the day, or at the latest time prior to the next work shift.

(96) (c) *(b)* Removal criteria for sling replacement shall be as follows:

(1) missing or illegible sling identification (see Section 9-2.5);

(2) for strand laid and single part slings ten randomly distributed broken wires in one rope lay, or five broken wires in one strand in one rope lay. See Fig. 10 describing component parts of rope, i.e., rope lay and strand.

(3) severe localized abrasion or scraping;

(4) kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure;

(5) evidence of heat damage;

(6) end attachments that are cracked, deformed, or worn to the extent that the strength of the sling is substantially affected;

(7) hooks should be inspected in accordance with ASME B30.10.

(8) severe corrosion of the rope or end attachments;

(9) multipart removal criteria for cable laid and braided slings.

	Allowable Broken Wires, Length (see Fig. 10)	
Sling Body	per lay	per braid
Cable laid	20	
Less than 8 part braid		20
8 part braid and more		40

Section 9-2.9: Operating Practices (96)

(a) Slings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with appropriate tables (see Section 9-2.6). When *D/d* ratios smaller than those listed in the tables are necessary, the rated load of the sling shall be decreased. Consult the sling manufacturer for specific data or refer to the WRTB Wire Rope Sling Users Manual.

(b) The weight of load shall be within the rated load of the sling.

(c) Slings shall be shortened or otherwise adjusted only by methods approved by the sling manufacturer.

(d) Slings shall not be shortened or lengthened by knotting, or by wire rope clips except as defined in para. 9-2.7.4.

(e) Slings that appear to be damaged shall not be used unless inspected and accepted as usable under Section 9-2.8.

(f) The sling shall be hitched in a manner providing control of the load.

(g) Sharp corners in contact with the sling should be

padded with material of sufficient strength to minimize damage to the sling.

(c) *(h)* All portions of the human body shall be kept from between the sling and the load and from between the sling and the crane hook or hoist hook.

(i) Personnel should stand clear of the suspended load.

(j) Personnel shall not ride the sling.

(k) Shock loading should be avoided.

(l) Slings should not be pulled from under a load when the load is resting on the sling.

(m) Slings should be stored in an area where they will not be subjected to mechanical damage, corrosive action, moisture, extreme heat, or kinking.

(n) Twisting and kinking the legs shall be avoided.

(o) The load applied to the hook should be centered in the base (bowl) of the hook to prevent point loading on the hook, unless the hook is designed for point loading.

(p) During lifting, with or without load, personnel shall be alert for possible snagging.

(q) In a basket hitch, the load should be balanced to prevent slippage.

(r) The sling's legs should contain or support the load so that the load remains under control.

(c) *(s)* Multiple leg slings shall be selected according to Tables 4 through 11 when used at the specific angles given in the table. Operation at other angles shall be limited to rated loads of the next lower angle given in the table or calculated trigonometrically [see paras. 9-2.3(d) and (e)] so as to not introduce into the leg itself a load in direct tension greater than that permitted.

(t) Slings should be long enough so that the rated load is adequate when the angle of the legs is taken into consideration.

(u) Slings should not be dragged on the floor or over an abrasive surface.

(v) In a choker hitch, slings shall be long enough so that the choker fitting chokes on the wire rope body and never on the other fitting.

(w) Do not inspect a sling by passing bare hands over the wire rope body. Broken wires, if present, may puncture the hands.

(x) Fiber core wire rope should not be subjected to degreasing or a solvent because of possible damage to the core.

(y) Single leg slings with hand tucked splices can be unlaid by rotation. Care should be taken to minimize sling rotation.

(z) An object engaging the eye of a loop eye sling should not be greater, in width, than one half the length of the loop eye.

(aa) For multiple leg slings used with nonsymmetrical loads, an analysis by a qualified person should be performed to prevent overloading of any leg. (a)

(ab) If extreme temperatures are involved, the guidance provided in paras. 9-2.6.1 and 9-2.6.2 shall be followed. (c)

CHAPTER 9-3
Metal Mesh Slings — Selection, Use, and Maintenance

Section 9-3.0: Scope

This Chapter covers only those metal mesh slings commonly manufactured. Slings requiring special end fittings, or in some other way deviating from the requirements described herein, are not covered.

Section 9-3.1: Construction

(c) **9-3.1.1 Fabric Construction.** Fabric for metal mesh slings shall be fabricated in accordance with the specifications in Table 12.

9-3.1.2 Fabric Materials

(a) Carbon Steel. The steel used in metal mesh slings shall be processed to produce the required mechanical properties.

(b) Other Materials. Other materials such as stainless steel, monel, or alloy steels may be used. When metal mesh slings are produced from such materials, the sling manufacturer shall provide specific data.

Section 9-3.2: Design Factor

The design factor for metal mesh slings shall be a minimum of 5.

(96) Section 9-3.3: Rated Load

The term *rated capacity* is commonly used to describe rated load.

(c) **9-3.3.1 Rated Load Table.** Rated loads are given in Table 13 for metal mesh slings covered in Section 9-3.1.

(c) **9-3.3.2 Basis for Rated Loads.** Rated loads for heavy duty, medium duty, and light duty slings shall be based on fabric in Table 12.

(c) **9-3.3.3 Rated Load for Nonstandard Slings.** The manufacturer should be consulted for specific data for slings which differ in width, materials, or design from those shown in Table 13.

Section 9-3.4: Proof Test (96) (c)

All new and repaired metal mesh slings shall be proof tested by the sling manufacturer or qualified person to a minimum of 2 times their vertical hitch rated load. Coated slings shall be proof tested before coating.

Section 9-3.5: Sling Identification (c)

9-3.5.1 Marking Requirements. Each sling shall be marked to show:

(a) name or trademark of manufacturer

(b) rated load for the type of hitch(es), and the angle upon which it is based

(c) width and gage

9-3.5.2 Sling identification shall be done by the sling manufacturer.

9-3.5.3 Maintenance of Sling Identification. Sling identification should be maintained by the user so as to be legible during the life of the sling.

Section 9-3.6: Effects of Environment

9-3.6.1 All slings covered by this Chapter may be used without derating in a temperature range from −20°F (−29°C) to 550°F (288°C) except elastomer coated slings.

9-3.6.2 All slings covered by this Chapter that are elastomer coated shall be used only in a temperature range from 0°F (−18°C) to 200°F (93°C).

9-3.6.3 For operation at temperatures outside these ranges or for other coatings, the manufacturer should be consulted for specific data.

9-3.6.4 Chemically active environments can destroy the strength of slings. Sling material can be susceptible to caustic damage or acid or acid fumes. Strongly oxidizing environments attack all common types of sling material. The sling manufacturer should be consulted before slings are used in chemically active environments.

(96) (c)

TABLE 12 FABRIC CONSTRUCTION (METAL MESH SLINGS)

	Heavy Duty	Medium Duty	Light Duty
Nominal spiral turns per foot of mesh width	35	43	59
Approx. spiral wire size	10 gage (0.135 in.)	12 gage (0.105 in.)	14 gage (0.080 in.)
Nominal cross rods per foot of fabric length	21	30	38
Approx. size of cross rods	8 gage (0.162 in.)	10 gage (0.135 in.)	14 gage (0.080 in.)
Nominal fabric thickness	$\frac{1}{2}$ in.	$\frac{3}{8}$ in.	$\frac{5}{16}$ in.

Section 9-3.7: Attachments and Components

9-3.7.1 End Fittings. The end fittings shall be designed to insure:

(a) at least the same rated load as the fabric;

(b) no visible permanent deformation after proof testing.

9-3.7.2 Attachment of End Fitting to Fabric. The fabric and end fittings shall be joined so that:

(a) the rated load of the sling is not reduced;

(b) the load is evenly distributed across the width of the fabric;

(c) sharp edges do not damage the fabric.

9-3.7.3 Sling Coatings. Slings may be painted, plated, impregnated, or molded with elastomers such as neoprene, polyvinyl chloride, urethane, or other suitable material. The coating shall not diminish the rated load of a sling.

Section 9-3.8: Inspection, Repair, and Removal

9-3.8.1 Type of Inspection

(96) *(a) Initial Inspection.* Before using any new or repaired sling, it shall be inspected to verify that the correct sling is being used as well as to determine that the sling meets the requirements of this Chapter.

(b) Frequent Inspection. This inspection should be made by the person handling the sling each day the sling is used.

(c) Periodic Inspection. This inspection should be conducted by designated personnel. Frequency of inspection should be based on:

(1) frequency of sling use;

(2) severity of service conditions;

(3) experience gained on the service life of slings used in similar applications.

Periodic inspections should be conducted at least annually.

9-3.8.2 Inspection Records. Written inspection records, utilizing the identification for each sling as established by the user, should be kept for all slings. These records should show a description of the new sling and its condition on each periodic inspection.

9-3.8.3 Repairs

(a) Metal mesh slings shall be repaired only by a metal mesh sling manufacturer or a qualified person. (96)

(b) When repaired, a sling shall be permanently marked to identify the repairing agency.

(c) All repaired mesh slings shall be proof load tested (see Section 9-3.4).

9-3.8.4 Removal Criteria. Slings shall be removed from service if damage such as the following is visible and shall only be returned to service when approved by a designated person: (c)

(a) missing or illegible sling identification (see Section 9-3.5);

(b) a broken weld or a broken brazed joint along the sling edge;

(c) a broken wire in any part of the mesh;

(d) reduction in wire diameter of 25% due to abrasion or 15% due to corrosion;

(e) lack of flexibility due to distortion of the mesh;

(f) distortion of the choker fitting so the depth of the slot is increased by more than 10%;

(g) distortion of either end fitting so the width of the eye opening is decreased by more than 10%;

(h) a 15% reduction of the original cross-sectional area of metal at any point around the hook opening of end fitting;

(i) visible distortion of either end fitting out of its plane;

(j) cracked end fitting.

Section 9-3.9: Operating Practices

(a) Slings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with appropriate tables (see Sections 9-3.3 and 9-3.6).

(b) The weight of the load shall be within the rated load of the sling.

(96) *(c)* Slings shall be shortened or otherwise adjusted only by methods approved by the sling manufacturer.

(d) Slings that appear to be damaged shall not be used unless inspected and accepted as usable under Section 9-3.8.

(e) The sling shall be hitched in a manner providing control of the load.

(f) Sharp corners in contact with the sling should be padded with material of sufficient strength to minimize damage to the sling.

(c) *(g)* All portions of the human body shall be kept from between the sling and the load, and from between the sling and the crane hook or hoist hook.

(h) Personnel should stand clear of the suspended load.

(i) Personnel shall not ride the sling.

(j) Shock loading should be avoided.

(k) Slings should not be pulled from under a load when the load is resting on the sling.

(l) Slings should be stored in an area where they will not be subjected to mechanical damage, corrosive action, moisture, extreme heat, or kinking.

(m) Twisting and kinking shall be avoided.

(n) During lifting, with or without load, personnel shall be alert for possible snagging.

(o) In a basket hitch, the load should be balanced to prevent slippage.

(p) Slings should not be dragged on the floor or over an abrasive surface.

(q) In a choker hitch, slings shall be long enough so that the choker fitting chokes on the mesh and never on the other fitting.

(r) In a choker hitch, the load should be balanced to prevent edge overload.

(s) A sling in which the spirals are locked or without free articulation shall not be used.

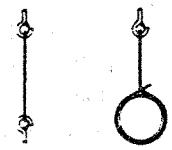
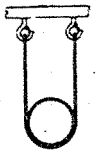
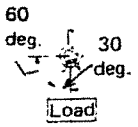
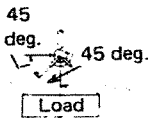
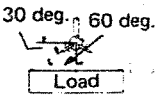
(t) Never hammer a sling to straighten a spiral or cross rod or to force a spiral into position.

(u) Slings used in pairs should be attached to a spreader beam.

(v) If extreme temperatures are involved, the guidance provided in Section 9-3.6 shall be followed. (c)

(96)
(c)

TABLE 13
RATED LOADS FOR METAL MESH SLINGS
(Design Factor = 5)

SLING WIDTH IN INCHES	 VERTICAL HITCH OR CHOKER HITCH	 VERTICAL BASKET HITCH	EFFECT OF ANGLE ON RATED CAPACITIES IN BASKET HITCH		
			 30 deg. Vertical 60 deg. Horizontal	 45 deg. Vertical 45 deg. Horizontal	 30 deg. Vertical 60 deg. Horizontal

Heavy Duty — 10 gage [Rated Loads in Pounds (lb)]

2	1,600	3,200	2,770	2,260	1,600
3	3,000	6,000	5,200	4,240	3,000
4	4,400	8,800	7,620	6,220	4,400
6	6,600	13,200	11,430	9,330	6,600
8	8,800	17,600	15,240	12,440	8,800
10	11,000	22,000	19,050	15,550	11,000
12	13,200	26,400	22,860	18,660	13,200
14	15,400	30,800	26,670	21,770	15,400
16	17,600	35,200	30,480	24,880	17,600
18	19,800	39,600	34,290	28,000	19,800
20	22,000	44,000	38,100	31,100	22,000

Medium Duty — 12 gage [Rated Loads in Pounds (lb)]

2	1,450	2,900	2,510	2,050	1,450
3	2,170	4,350	3,770	3,070	2,170
4	2,900	5,800	5,020	4,100	2,900
6	4,800	9,600	8,310	6,780	4,800
8	6,400	12,800	11,080	9,050	6,400
10	8,000	16,000	13,850	11,310	8,000
12	9,600	19,200	16,620	13,570	9,600
14	11,200	22,400	19,400	15,830	11,200
16	12,800	25,600	22,170	18,100	12,800
18	13,500	27,000	23,380	19,090	13,500
20	15,000	30,000	25,980	21,210	15,000

Light Duty — 14 gage [Rated Loads in Pounds (lb)]

2	900	1,800	1,560	1,270	900
3	1,400	2,800	2,420	1,980	1,400
4	2,000	4,800	4,150	3,390	2,000
6	3,000	6,000	5,190	4,240	3,000
8	4,000	8,000	6,920	5,650	4,000
10	5,000	10,000	8,660	7,070	5,000
12	6,000	12,000	10,390	8,480	6,000
14	7,000	14,000	12,120	9,890	7,000
16	8,000	16,000	13,850	11,310	8,000
18	9,000	18,000	15,580	12,720	9,000
20	10,000	20,000	17,320	14,140	10,000

CHAPTER 9-4 (a)
Synthetic Rope Slings — Selection, Use, and Maintenance

Section 9-4.0: Scope

This Chapter covers slings made from synthetic fiber rope manufactured and tested in accordance with the following Cordage Institute specifications:

Rope Type	Designation
Nylon 3-Strand Laid	CI 1303
Nylon 8-Strand Plaited	CI 1303
Nylon Double Braided	CI 1306
Polyester 3-Strand Laid	CI 1304
Polyester 8-Strand Plaited	CI 1304
Polyester Double Braid	CI 1307
Polyester Single Braid	CI 1305
Polypropylene 3-Strand Laid	CI 1301
Polypropylene 8-Strand Laid	CI 1301

Section 9-4.1: Rope Material and Construction

9-4.1.1 Constructions. Rope constructions covered are:

(a) 3-strand laid
(b) 8-strand plaited
(c) hollow braided

Rope sizes covered are from ½ in. diameter to 3 in. diameter.

9-4.1.2 Materials. Fiber materials covered for use in the constructions of the synthetic ropes are:

(a) nylon
(b) polyester
(c) polypropylene

9-4.1.3 Other Synthetic Ropes. Other synthetic ropes are available and may be used as slings. Consult the sling manufacturer or qualified person for information on the suitability for use in slings and the appropriate rated load.

Section 9-4.2: Design Factor

The design factors for synthetic rope slings shall be a minimum of 5.

Section 9-4.3: Rated Load

The term *rated capacity* is commonly used to describe rated load.

9-4.3.1 Rated Load Tables. Rated loads are given in Tables 14, 15, and 16 for synthetic rope slings designated in Section 9-4.1. (c)

9-4.3.2 Other Configurations. Tables 14 through 16 show rated loads for single leg slings and endless slings. Rated loads for bridle slings, for basket hitches where both legs are not vertical, and for consideration of the angle between basket hitch slings (see Figs. 1 and 2), the following equation shall be applicable: (b) (c)

rated load = single leg sling vertical hitch rated load × number of legs × sine of minimum horizontal angle

Sines
30 deg. — 0.500
45 deg. — 0.707
60 deg. — 0.866

For slings used in a choker hitch, rated loads in Tables 14 through 16 are for an angle of 120 deg. or greater for the angle formed in the rope body as it passes through the choking eye.

Section 9-4.4: Proof Test

When specified by the purchaser, synthetic fiber rope slings shall be proof loaded to two times the vertical hitch rated load. (c)

Section 9-4.5: Sling Identification

9-4.5.1 Marking Requirements. Each sling shall be marked to show:

(a) name or trademark of manufacturer
(b) manufacturer's code or stock number
(c) rated load for the type of hitch
(d) type of material and construction
(e) date of manufacture

(c) **9-4.5.2** Sling identification shall be done by the sling manufacturer.

(c) **9-4.5.3 Maintenance of Sling Identification.** Sling identification shall be maintained by the user so as to be legible during the life of the sling.

Section 9-4.6: Effects of Environment

(c) **9-4.6.1 Temperature.** Nylon and polyester slings shall not be used in contact with objects or at temperatures in excess of 194°F (90°C), or below −40°F (−40°C). Polypropylene slings shall not be used in contact with objects or at temperatures in excess of 150°F (66°C), or below −40°F (−40°C). Storage or long term exposure to elevated temperatures, including the upper range of those cited above, will gradually weaken synthetic ropes; for such applications, consult the sling manufacturer.

9-4.6.2 Sunlight and Ultraviolet. Ropes made of polypropylene fiber shall be made of fiber that has been produced with an appropriate ultraviolet inhibitor. Ropes made of nylon fiber should be made of fiber that has been produced with an appropriate ultraviolet inhibitor. Nylon and particularly polypropylene ropes subjected to long term storage or use in sunlight must be subject to a suitable retirement criteria depending on exposure levels; consult the sling manufacturer.

9-4.6.3 Chemically Active Environments. Certain chemically active environments may weaken or destroy synthetic rope slings. In general, acids may affect nylon and strong alkalis may affect polyester, both aggravated by elevated temperatures. In general, polypropylene may be affected by volitile petroleum and other solvents and most hydrocarbons at elevated temperatures. The presence of rust in wet nylon ropes has been found to be potentially harmful. Consult the sling manufacturer before using slings in a chemically active environment.

Section 9-4.7: Splicing and Fittings

9-4.7.1 Splicing. Splicing by an approved method is the preferred method for configuring eye-and-eye slings or endless slings. All splices shall be made in accordance with splicing instructions provided by the rope manufacturer or the Cordage Institute. In addition, the following shall be observed:

(a) For tuck splices in 3-strand and 8-strand synthetic ropes no less than four full tucks shall be used. Short splices shall contain at least six full tucks, three on each side of the center of the splice.

(b) Strand end tails in all tuck splices shall not be trimmed short (cut flush with the body of the rope). In cases where the projecting tails may be objectionable, the tails shall be tapered and buried into the body of the rope using two additional tucks.

(c) Synthetic rope slings shall have a minimum undisturbed length of rope of ten times the rope diameter between the last tuck of tuck splices or between the ends of the buried tails or strands of other types of splices.

(d) Knots, clips, or clamps shall not be used to join ropes to produce eye-and-eye slings or endless slings.

(e) When configuring slings, mechanical or socketed fittings used to create eyes or join ropes, in lieu of splices, should be used with caution. Suitability should be verified by a qualified person.

(f) For all eye splices, the eye shall be sufficiently large to provide an included angle of not more than 60 deg. at the apex of the splice when the eye is placed over the hook, under the load, or on any other load bearing device (see Fig. 2).

9-4.7.2 Fittings. Mechanical fittings used as part of a synthetic rope sling shall be selected to meet the following requirements:

(a) The material shall be compatible with the mechanical and environmental requirements imposed on the sling.

(b) The fittings shall have sufficient strength to sustain twice the rated load of the sling without permanent deformation and shall have a minimum breaking strength equal to five times the rated load of the sling.

(c) All surfaces shall be cleanly finished and sharp edges removed so as not to cause damage to the rope.

(d) Slings incorporating reused, repaired, or welded fittings shall undergo proof test of the fitting or the sling to twice the rated load.

(e) Slings incorporating aluminum fittings shall not be used where fumes, vapors, sprays, mists, or liquids of alkalis or acids are present.

(f) The opening in the fitting shall be of the proper shape and size to ensure that the fitting will seat properly in the hook or other attachment.

(g) Appropriate thimbles should be used in the sling whenever possible. Thimbles should have closed ears that will prevent the thimble from falling out of the eye or rotating inside it; if not, the thimble should be

lashed to the rope. Thimbles shall have a diameter at the bearing surface at least equal to twice the rope diameter.

9-4.7.3 Knots. Knots significantly reduce the strength of fiber rope, are unpredictable, and shall not be used to configure rope slings.

Section 9-4.8: Inspection, Repair, and Removal

9-4.8.1 Type of Inspection

(a) Initial Inspection. Prior to use, all new or modified slings shall be inspected to ensure that the correct sling is being used as well as to determine that the sling meets the requirements of this Standard.

(b) Frequent Inspection. This inspection should be made by the person handling the sling each day the sling is used.

(c) Periodic Inspection. This inspection should be conducted by designated personnel. Frequency of inspection should be based on:

(1) frequency of sling use;

(2) severity of sling use; and

(3) experience gained on the service life of slings used in similar applications.

Periodic inspections should be conducted at least annually.

9-4.8.2 Inspection Records. Written inspection records, utilizing the identification for each sling as established by the user, should be kept for all slings. These records should show a description of the new sling and its condition on each periodic inspection.

9-4.8.3 Repair. The ropes that make up the sling shall not be respliced or knotted to effect repairs. Repaired or reused fittings shall be proof tested in accordance with para. 9-4.7.2(d).

(c) **9-4.8.4 Removal Criteria.** A sling shall be removed from service if damage such as the following is visible and shall only be returned to service when approved by a designated person.

(a) missing or illegible sling identification; see para. 9-4.5.1;

(b) cuts, gouges, areas of extensive fiber breakage along the length, and abraded areas on the rope. Damage that is estimated to have reduced the effective diameter of the rope by more than 10% is cause for removal;

(c) uniform fiber breakage along the major part of the length of the rope in the sling such that the entire rope appears covered with fuzz or whiskers;

(d) fiber breakage or melted fiber (manifested by hard masses) inside the rope that appears along the length at the same relative position and involves damage estimated at 10% of the fiber in the strand at that point.

(1) To accomplish this, pry or twist the rope open for inspection.

(2) After inspection, smooth and roll the lay.

(e) discoloration, brittle fibers, and hard or stiff areas may mean chemical or ultraviolet damage;

(f) foreign matter that has permeated the rope and attracts and holds grit;

(g) kinks or distortion in the rope structure, particularly if caused by forcibly pulling on loops (known as hockles);

(h) melted or charred areas that affect more than 10% of the diameter of the rope or affect several adjacent strands along the length to more than 10% of their individual diameters. These areas will generally be quite hard compared to unaffected areas;

(i) poor condition of thimbles or other fittings manifested by corrosion, cracks, distortion, or localized wear;

(j) other visible damage that causes doubt as to the strength of the sling.

Section 9-4.9: Operating Practices

(a) Slings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with appropriate tables (see Sections 9-4.3 and 9-4.6).

(b) The weight of the load shall be within the rated load of the sling.

(c) Slings shall be shortened or otherwise adjusted only by methods approved by the sling manufacturer.

(d) Slings that appear to be damaged shall not be used unless inspected and accepted under Section 9-4.8.

(e) The sling shall be hitched in a manner providing control of the load.

(f) Sharp corners in contact with the sling should be padded with protective material of sufficient strength and thickness to minimize damage to the sling.

(g) All portions of the human body shall be kept from between the sling and the load and from between the sling and the crane or hoist hook. (c)

(h) Personnel should never stand in line with or next to the legs of a synthetic rope sling that is under tension.

(i) Personnel shall stand clear of the suspended load.

(j) Personnel shall not ride the sling.

(k) Shock loading should be avoided.

(l) Slings should not be pulled from under a load when the load is resting on the sling.

(m) Slings should not be stored in an area where they may be subjected to mechanical, chemical, or ultraviolet damage, or where the temperatures may be elevated; refer to para. 9-4.6.1. Do not store nylon ropes in areas where they may become impregnated with rust.

(n) Slings exposed to salt water should be thoroughly rinsed with fresh water to prevent mechanical damage from salt crystals should the rope dry.

(o) Slings should not be used if made from ropes less than ½ in. (13 mm) in diameter, since small ropes are more vulnerable to damage from cuts and abrasion.

(p) The load applied to the hook should be centered in the base (bowl) of the hook to prevent point loading on the hook.

(q) During lifting, with or without load, personnel shall be alert for possible snagging.

(r) In a basket hitch, the load should be balanced to prevent slippage.

(s) When using a basket hitch, the legs of the sling should contain or support the load from the sides, above the center of gravity so that the load remains under control.

(t) Slings should be long enough so that the rated load is adequate when the angle of the legs is taken into consideration (see para. 9-4.3.2).

(u) Slings should not be dragged on the floor or over an abrasive surface.

(v) In a choker hitch, slings shall be long enough so that the point of the choke is on the rope and not on any part of the splice or on fittings.

(w) If extreme temperatures are involved, the guidance provided in para. 9-4.6.1 shall be followed. (c)

(c)

TABLE 14
NYLON ROPE SLINGS

Rope Diameter, Nominal, in.	Rated Load in Pounds (Design Factor = 5)											
	Eye-and-Eye Sling						Endless Sling					
			Basket Hitch						Basket Hitch			
			Angle of Rope to Horizontal						Angle of Rope to Horizontal			
			90 deg.	60 deg.	45 deg.	30 deg.			90 deg.	60 deg.	45 deg.	30 deg.
	Vertical Hitch	Choker Hitch	Angle of Rope to Vertical				Vertical Hitch	Choker Hitch	Angle of Rope to Vertical			
			0 deg.	30 deg.	45 deg.	60 deg.			0 deg.	30 deg.	45 deg.	60 deg.
1/2	1,100	830	2,200	1,900	1,600	1,100	2,000	1,500	4,000	3,500	2,800	2,000
9/16	1,400	1,100	2,800	2,400	2,000	1,400	2,600	2,000	5,200	4,500	3,700	2,600
5/8	1,800	1,400	3,600	3,100	2,500	1,800	3,200	2,400	6,400	5,500	4,500	3,200
3/4	2,600	2,000	5,200	4,500	3,700	2,600	4,600	3,500	9,200	8,000	6,500	4,600
7/8	3,500	2,600	7,000	6,100	4,900	3,500	6,200	4,700	12,400	10,700	8,800	6,200
1	4,400	3,300	8,800	7,600	6,200	4,400	7,900	5,900	15,800	13,700	11,200	7,900
1 1/8	5,700	4,300	11,400	9,900	8,100	5,700	10,100	7,600	20,200	17,500	14,300	10,100
1 1/4	7,000	5,300	14,000	12,100	9,900	7,000	12,400	9,300	24,800	21,500	17,500	12,400
1 5/16	7,700	5,800	15,400	13,300	10,900	7,700	13,700	10,300	27,400	23,700	19,400	13,700
1 1/2	9,700	7,300	19,400	16,800	13,700	9,700	17,400	13,100	34,800	30,100	24,600	17,400
1 5/8	11,500	8,600	23,000	19,900	16,300	11,500	20,500	15,400	41,000	35,500	29,000	20,500
1 3/4	13,200	9,900	26,400	22,900	18,700	13,200	23,600	17,700	47,200	40,900	33,400	23,600
2	16,900	12,700	33,800	29,300	23,900	16,900	30,200	22,700	60,400	52,300	42,700	30,200
2 1/8	19,100	14,300	38,200	33,100	27,000	19,100	34,100	25,600	68,200	59,100	48,200	34,100
2 1/4	21,400	16,100	42,800	37,100	30,300	21,400	38,300	28,700	76,600	66,300	54,200	38,300
2 1/2	26,300	19,700	52,600	45,600	37,200	26,300	46,900	35,200	93,800	81,200	66,300	46,900
2 5/8	28,800	21,600	57,600	49,900	40,700	28,800	51,400	38,600	102,800	89,000	72,700	51,400
3	37,100	27,800	74,200	64,300	52,500	37,100	66,200	49,700	132,400	114,700	93,600	66,200

GENERAL NOTE: See Figs. 1 and 2 for sling description.

(c)

TABLE 15
POLYESTER ROPE SLINGS

Rope Diameter, Nominal, in.	Rated Load in Pounds (Design Factor = 5)											
	Eye-and-Eye Sling						Endless Sling					
			Basket Hitch						Basket Hitch			
			Angle of Rope to Horizontal						Angle of Rope to Horizontal			
			90 deg.	60 deg.	45 deg.	30 deg.			90 deg.	60 deg.	45 deg.	30 deg.
	Vertical Hitch	Choker Hitch	Angle of Rope to Vertical				Vertical Hitch	Choker Hitch	Angle of Rope to Vertical			
			0 deg.	30 deg.	45 deg.	60 deg.			0 deg.	30 deg.	45 deg.	60 deg.
1/2	1,000	750	2,000	1,700	1,400	1,000	1,800	1,400	3,600	3,100	2,500	1,800
9/16	1,300	980	2,600	2,300	1,800	1,300	2,300	1,700	4,600	4,000	3,300	2,300
5/8	1,600	1,200	3,200	2,800	2,300	1,600	2,800	2,100	5,600	4,800	4,000	2,800
3/4	2,200	1,700	4,400	3,800	3,100	2,200	4,000	3,000	8,000	6,900	5,700	4,000
7/8	3,000	2,300	6,000	5,200	4,200	3,000	5,400	4,100	10,800	9,400	7,600	5,400
1	4,000	3,000	8,000	6,900	5,700	4,000	7,100	5,300	14,200	12,300	10,000	7,100
1 1/8	5,000	3,800	10,000	8,700	7,100	5,000	8,900	6,700	17,800	15,400	12,600	8,900
1 1/4	6,000	4,500	12,000	10,400	8,500	6,000	10,600	8,000	21,200	18,400	15,000	10,600
1 5/16	6,500	4,900	13,000	11,300	9,200	6,500	11,600	8,700	23,200	20,100	16,400	11,600
1 1/2	8,400	6,300	16,800	14,500	11,900	8,400	15,100	11,300	30,200	26,200	21,400	15,100
1 5/8	9,900	7,400	19,800	17,100	14,000	9,900	17,600	13,200	35,200	30,500	24,900	17,600
1 3/4	11,400	8,600	22,800	19,700	16,100	11,400	20,400	15,300	40,800	35,300	28,800	20,400
2	14,400	10,800	28,800	24,900	20,400	14,400	25,700	19,300	51,400	44,500	36,300	25,700
2 1/8	16,200	12,200	32,400	28,100	22,900	16,200	28,900	21,700	57,800	50,100	40,900	28,900
2 1/4	18,100	13,600	36,200	31,300	25,600	18,100	32,300	24,200	64,600	55,900	45,700	32,300
2 1/2	22,000	16,500	44,000	38,100	31,100	22,000	39,300	29,500	78,600	68,100	55,600	39,300
2 5/8	24,200	18,200	48,400	41,900	34,200	24,200	43,200	32,400	86,400	74,800	61,100	43,200
3	31,200	23,400	62,400	54,000	44,100	31,200	55,700	41,800	111,400	96,500	78,800	55,700

GENERAL NOTE: See Figs. 1 and 2 for sling description.

(c)

TABLE 16
POLYPROPYLENE ROPE SLINGS

Rope Diameter, Nominal, in.	Rated Load in Pounds (Design Factor = 5)											
	Eye-and-Eye Sling						Endless Sling					
			Basket Hitch						Basket Hitch			
			Angle of Rope to Horizontal						Angle of Rope to Horizontal			
			90 deg.	60 deg.	45 deg.	30 deg.			90 deg.	60 deg.	45 deg.	30 deg.
	Vertical Hitch	Choker Hitch	Angle of Rope to Vertical				Vertical Hitch	Choker Hitch	Angle of Rope to Vertical			
			0 deg.	30 deg.	45 deg.	60 deg.			0 deg.	30 deg.	45 deg.	60 deg.
1/2	760	570	1,500	1,300	1,100	750	1,400	1,100	2,800	2,400	2,000	1,400
9/16	920	690	1,800	1,600	1,300	900	1,600	1,200	3,200	2,800	2,300	1,600
5/8	1,100	830	2,200	1,900	1,600	1,100	2,000	1,500	4,000	3,500	2,800	2,000
3/4	1,500	1,100	3,000	2,600	2,100	1,500	2,700	2,000	5,400	4,700	3,800	2,700
7/8	2,100	1,600	4,200	3,600	3,000	2,100	3,700	2,800	7,400	6,400	5,200	3,700
1	2,600	2,000	5,200	4,500	3,700	2,600	4,600	3,500	9,200	8,000	6,500	4,600
1 1/8	3,200	2,400	6,400	5,500	4,500	3,200	5,700	4,300	11,400	9,900	8,100	5,700
1 1/4	3,900	2,900	7,800	6,800	5,500	3,900	6,900	5,200	13,800	12,000	9,800	6,900
1 5/16	4,200	3,200	8,400	7,300	5,900	4,200	7,600	5,700	15,200	13,200	10,700	7,600
1 1/2	5,500	4,100	11,000	9,500	7,800	5,500	9,800	7,400	19,600	17,000	13,900	9,800
1 5/8	6,400	4,800	12,800	11,100	9,000	6,400	11,400	8,600	22,800	19,700	16,100	11,400
1 3/4	7,400	5,600	14,800	12,800	10,500	7,400	13,200	9,900	26,400	22,900	18,700	13,200
2	9,400	7,100	18,800	16,300	13,300	9,400	16,700	12,500	33,400	28,900	23,600	16,700
2 1/8	10,500	7,900	21,000	18,200	14,800	10,500	18,800	14,100	37,600	32,600	26,600	18,800
2 1/4	11,900	8,900	23,800	20,600	16,800	11,900	21,200	15,900	42,400	36,700	30,000	21,200
2 1/2	14,400	10,800	28,800	24,900	20,400	14,400	25,700	19,300	51,400	44,500	36,300	25,700
2 5/8	16,100	12,100	32,200	27,900	22,800	16,100	28,800	21,600	57,600	49,900	40,700	28,800
3	20,500	15,400	41,000	35,500	29,000	20,500	36,600	27,500	73,200	63,400	51,800	36,600

GENERAL NOTE: See Figs. 1 and 2 for sling description.

CHAPTER 9-5
Synthetic Webbing Slings — Selection, Use, and Maintenance

Section 9-5.0: Scope

This Chapter applies to slings fabricated by sewing woven synthetic webbing of nylon or polyester type yarns, for the purpose of hoisting, lifting, and general material handling, in basic sling types as illustrated in Fig. 7.

Section 9-5.1: Construction

9-5.1.1 Webbing. Webbing should be woven of high tenacity synthetic yarns, offering suitable characteristics for use in the fabrication of web slings. Webbing shall have the following characteristics.

(a) sufficient certified tensile strength to meet the sling manufacturer's requirements;

(b) uniform thickness and width;

(c) full woven width, including selvage edges;

(d) webbing ends shall be sealed by heat, or other suitable means, to prevent raveling.

9-5.1.2 Thread. The thread used in the manufacture of synthetic web slings shall be of the same generic type yarn as the sling webbing.

9-5.1.3 Stitching. Stitching shall be the only method used to fabricate synthetic web slings within the scope of this Standard.

(a) The stitching pattern and length of stitching shall be in accordance with the manufacturer's standard practice.

(b) The stitching in all load bearing splices shall be of sufficient strength to maintain the sling design factor.

(c) All stitches shall be lock-stitched and preferably continuous. When not continuous, it shall be back stitched at the ends to prevent raveling.

9-5.1.4 Coatings. Slings may be coated with suitable material that will impart desirable characteristics such as:

(a) abrasion resistance;

(b) sealing to prevent penetration of foreign particles and matter;

(c) increased coefficient of friction;

(d) protection from sunlight or ultraviolet degradation.

Section 9-5.2: Design Factor

The design factor for synthetic web slings shall be a minimum of 5.

Section 9-5.3: Rated Load (96)

The term *rated capacity* is commonly used to describe rated load.

(a) Single leg slings fall into the classifications shown in Tables 17 through 24. A sling shall not be used at a load greater than that shown in the appropriate table or on its tag. Slings not shown in these tables shall be used in accordance with the manufacturer's recommendations (such as multi-ply slings). (a) (c)

(b) Each manufacturer shall make available on request test data to justify these recommended rated loads.

(c) Horizontal angles less than 30 deg. should not be used.

(d) For rated loads of bridle slings, where both legs are not vertical and for consideration of the angle between basket hitch slings, the following equation shall be applicable. (c)

rated load = single leg vertical hitch rated load[1] × number of legs × sine of minimum horizontal angle

Sines
30 deg. — 0.500
45 deg. — 0.707
60 deg. — 0.866

(e) The rated load, in choker hitch, of single leg slings shall be a maximum of 80% of the vertical rated loads as shown in Tables 17 through 24. (a) (c)

[1] See Tables 17 through 24. (a) (c)

Section 9-5.4: Proof Test

When specified by the purchaser, web slings of all types shall be proof loaded:

(c) *(a)* The proof load for single leg slings and endless slings shall be two times the vertical hitch rated load.

(c) *(b)* The proof load for multiple leg bridle slings shall be applied to the individual legs and shall be two times the vertical hitch rated load of a single leg sling.

(96) (c) ### Section 9-5.5: Sling Identification

9-5.5.1 Marking Requirements. Each sling shall be marked to show:

(a) name or trademark of manufacturer

(b) manufacturer's code or stock number

(c) rated load for the types of hitch(es), and the angle upon which it is based

(d) type of synthetic web material

9-5.5.2 Sling identification shall be done by the sling manufacturer.

9-5.5.3 Maintenance of Sling Identification. Sling identification should be maintained by the user so as to be legible during the life of the sling.

Section 9-5.6: Effects of Environment

9-5.6.1 Chemically active environments, such as acids and caustics, can affect the strength of slings. The sling manufacturer should be consulted before slings are used in chemically active environments.

(c) **9-5.6.2** Nylon and polyester slings shall not be used in contact with object or at temperatures in excess of 194°F (90°C) or below –40°F (–40°C).

Section 9-5.7: Fittings

(a) The material selected shall be compatible with the mechanical and environmental requirements imposed on the fitting. Material selected should be carbon steel, alloy steel, aluminum, or other suitable material.

(b) Fittings shall have sufficient strength to sustain twice the rated load of the sling without permanent deformation and a minimum breaking strength equal to five times the rated load of the sling.

(c) All surfaces shall be cleanly finished and sharp edges removed so as not to cause damage to the webbing.

(d) Slings incorporating reused or welded fittings shall be proof tested to two times the rated load of the sling.

(e) Slings incorporating aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of caustics, or acids are present.

(f) The eye opening in the fitting shall be the proper shape and size to ensure that the fitting will seat properly in the hook or other attachment.

Section 9-5.8: Repairs, Inspection, and Removal (a)

9-5.8.1 Type of Inspection

(a) Initial Inspection. Before using any new, repaired, or modified sling, it shall be inspected to ensure that the correct sling is being used as well as to determine that the sling meets the requirements of this Standard.

(b) Frequent Inspection. This inspection should be made by the person handling the sling each day the sling is used.

(c) Periodic Inspection. This inspection should be conducted by designated personnel. Frequency of inspection should be based on:

(1) frequency of sling use;

(2) severity of service conditions; and

(3) experience gained on the service life of slings used in similar applications.

9-5.8.2 Inspection Records. Written inspection records, utilizing the identification for each sling as established by the user, should be kept for all slings. These records should show a description of the new sling and its condition on each periodic inspection.

9-5.8.3 Repairs

(a) Slings shall be repaired only by a sling manufacturer or a qualified person. When repaired, a sling shall be marked to identify the repair agent.

(b) Temporary repairs of either webbing, fittings, or stitching shall not be permitted.

(c) Repaired sling shall be proof tested to two times its assigned rated load before being put back into service.

9-5.8.4 Removal Criteria. A sling shall be removed from service if damage such as the following is visible and shall only be returned to service when approved by a designated person: (c)

(a) missing or illegible sling identification. See Section 9-5.5.

(b) acid or caustic burns;

(c) melting or charring of any part of the sling;

(d) holes, tears, cuts, or snags;

(e) broken or worn stitching in load bearing splices;

(f) excessive abrasive wear;

(g) knots in any part of the sling;

(h) excessive pitting or corrosion, or cracked, distorted, or broken fittings;

(i) other visible damage that causes doubt as to the strength of the sling.

Section 9-5.9: Operating Practices

(a) Slings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with appropriate tables (see Sections 9-5.3 and 9-5.6).

(b) The weight of load shall be within the rated load of the sling.

(c) Slings shall be shortened , lengthened, or adjusted only by methods approved by the sling manufacturer.

(d) Slings shall not be shortened or lengthened by knotting.

(e) Slings that appear to be damaged shall not be used unless inspected and accepted as usable under Section 9-5.8.

(f) Sling shall be hitched in a manner providing control of the load.

(g) Sharp corners in contact with the sling should be padded with material of sufficient strength to minimize damage to the sling.

(c) *(h)* All portions of the human body shall be kept from between the sling and the load, and from between the sling and the crane hook or hoist hook.

(i) Personnel should stand clear of the suspended load.

(j) Personnel shall not ride the sling.

(k) Shock loading should be avoided.

(l) Slings should not be pulled from under a load when the load is resting on the sling.

(m) Slings should be stored in a cool, dry, and dark place to prevent environmental damage.

(n) Twisting and kinking the legs shall be avoided.

(o) Load applied to the hook should be centered in the base (bowl) of hook to prevent point loading on the hook.

(p) During lifting, with or without load, personnel shall be alert for possible snagging.

(q) In a basket hitch, the load should be balanced to prevent slippage.

(r) The sling's legs should contain or support the load from the sides above the center of gravity when using a basket hitch.

(s) Slings should be long enough so that the rated load is adequate when the angle of the legs is taken into consideration [see para. 9-5.3(c)].

(t) Slings should not be dragged on the floor or over an abrasive surface.

(u) In a choker hitch, slings shall be long enough so the choker fitting chokes on the webbing and never on the other fitting.

(v) If extreme temperatures are involved, the guidance provided in para. 9-5.6.2 shall be followed. (c)

(w) When extensive exposure to sunlight or ultraviolet light is experienced by nylon or polyester web slings, the sling manufacturer should be consulted for recommended inspection procedure.

TABLE 17 (a) (c)
RATED LOAD CHARTS — SINGLE LEG SLINGS
(Design Factor = 5)
Class 5 [Notes (1) and (3)]
Vertical Hitch Rating — 1 Ply Slings

Width		Types I, II, III, IV [Note (2)]		Type V [Notes (2) and (4)]	
in.	mm	lb	kg	lb	kg
1	25	1,100	500	2,200	1000
1½	38	1,600	725	3,200	1450
1¾	44	1,900	875	3,800	1700
2	50	2,200	1000	4,400	2000
3	75	3,300	1500	6,600	3000
4	100	4,400	2000	8,800	4000
5	125	5,500	2500	11,000	5000
6	150	6,600	3000	13,200	6000

NOTES:
(1) Class 5 means rated loads are based on a stuffer weave construction webbing possessing a minimum certified tensile strength of 6,800 lb/in. width (47 000 kPa).
(2) See Fig. 7. (For Type VI, consult the manufacturer for rated loads.)
(3) The rated load, in choker hitch, of single leg slings shall be a maximum of 80% of the vertical hitch rated load as shown in Table 17.
(4) The rated loads for Type V slings are based on untapered slings. Folding or bunching which occurs when used with shackles, hooks, or other applications, will reduce the rated load. Consult the manufacturer.

TABLE 18 (a) (c)
RATED LOAD CHARTS — SINGLE LEG SLINGS
(Design Factor = 5)
Class 7 [Notes (1) and (3)]
Vertical Hitch Rating — 1 Ply Slings

Width		Types I, II, III, IV [Note (2)]		Type V [Notes (2) and (4)]	
in.	mm	lb	kg	lb	kg
1	25	1,600	725	3,200	1450
1½	38	2,300	1025	4,600	2075
1¾	44	2,700	1225	5,400	2450
2	50	3,100	1400	6,200	2800
3	75	4,700	2125	9,400	4225
4	100	6,200	2800	12,400	5600
5	125	7,800	3500	15,600	7025
6	150	9,300	4200	18,600	8400
8	200	11,750	5350	21,150	9600
10	250	14,700	6650	26,450	12000
12	300	17,650	8000	31,750	14400

NOTES:
(1) Class 7 means rated loads are based on a stuffer weave construction webbing possessing a minimum certified tensile strength of 9,800 lb/in. width (67 500 kPa).
(2) See Fig. 7. (For Type VI, consult the manufacturer for rated loads.)
(3) The rated load, in choker hitch, of single leg slings shall be a maximum of 80% of the vertical hitch rated load as shown in Table 18.
(4) The rated loads for Type V slings are based on untapered slings. Folding or bunching which occurs when used with shackles, hooks, or other applications, will reduce the rated load. Consult the manufacturer.

TABLE 19 (a) (c)
RATED LOAD CHARTS — SINGLE LEG SLINGS
(Design Factor = 5)
Class 5 [Notes (1) and (3)]
Vertical Hitch Rating — 2 Ply Slings

Width		Types I, II, III, IV [Note (2)]		Type V [Notes (2) and (4)]	
in.	mm	lb	kg	lb	kg
1	25	2,200	1000	4,400	2000
1½	38	3,300	1500	6,600	3000
1¾	44	3,800	1800	7,600	3400
2	50	4,400	2000	8,800	4000
3	75	6,600	3000	13,200	6000
4	100	8,200	3700	16,400	7400
5	125	10,200	4600	20,400	9200
6	150	12,300	5550	24,600	11000

NOTES:
(1) Class 5 means rated loads are based on a stuffer weave construction webbing possessing a minimum certified tensile strength of 6,800 lb/in. width (47 000 kPa).
(2) See Fig. 7. (For Type VI, consult the manufacturer for rated loads.)
(3) The rated load, in choker hitch, of single leg slings shall be a maximum of 80% of the vertical hitch rated load as shown in Table 19.
(4) The rated loads for Type V slings are based on untapered slings. Folding or bunching which occurs when used with shackles, hooks, or other applications, will reduce the rated load. Consult the manufacturer.

TABLE 20 (a) (c)
RATED LOAD CHARTS — SINGLE LEG SLINGS
(Design Factor = 5)
Class 7 [Notes (1) and (3)]
Vertical Hitch Rating — 2 Ply Slings

Width		Types I, II, III, IV [Note (2)]		Type V [Notes (2) and (4)]	
in.	mm	lb	kg	lb	kg
1	25	3,100	1400	6,200	2800
1½	38	4,700	2125	9,400	4225
1¾	44	5,400	2450	10,800	4900
2	50	6,200	2800	12,400	5600
3	75	8,800	4000	17,600	7900
4	100	11,000	5000	22,000	10000
5	125	13,700	6200	27,400	12300
6	150	16,500	7400	33,000	15000
8	200	22,750	10350	42,350	19250
10	250	28,400	12900	52,900	24000
12	300	34,100	15500	63,500	28850

NOTES:
(1) Class 7 means rated loads are based on a stuffer weave construction webbing possessing a minimum certified tensile strength of 9,800 lb/in. width (67 500 kPa).
(2) See Fig. 7. (For Type VI, consult the manufacturer for rated loads.)
(3) The rated load, in choker hitch, of single leg slings shall be a maximum of 80% of the vertical hitch rated load as shown in Table 20.
(4) The rated loads for Type V slings are based on untapered slings. Folding or bunching which occurs when used with shackles, hooks, or other applications, will reduce the rated load. Consult the manufacturer.

(c)

TABLE 21
RATED LOAD CHARTS — SINGLE LEG SLINGS
(Design Factor = 5)
Class 5 [Notes (1) and (3)]
Vertical Hitch Rating — 3 Ply Slings

Width			Type V [Note (2)]	
in.	mm	Types I, II, III, IV	lb	kg
1	25	Rated Loads Not Developed	5,500	2,500
1¾	44		9,650	4,400
2	50		11,000	5,000
3	75		15,900	7,200
4	100		21,200	9,600
5	125		26,500	12,050
6	150		31,800	14,450

NOTES:
(1) Class 5 means rated loads are based on a stuffer weave construction webbing possessing a minimum certified tensile strength of 6,800 lb/in. width (47 000 kPa).
(2) The rated loads for Type V slings are based on untapered slings. Folding or bunching which occurs when used with shackles, hooks, or other applications, will reduce the rated load. Consult the manufacturer.
(3) The rated load, in choker hitch, of single leg slings shall be a maximum of 80% of the vertical hitch rated load as shown in Table 21.

(c)

TABLE 22
RATED LOAD CHARTS — SINGLE LEG SLINGS
(Design Factor = 5)
Class 7 [Notes (1) and (3)]
Vertical Hitch Rating — 3 Ply Slings

Width			Type V [Note (2)]	
in.	mm	Types I, II, III, IV	lb	kg
1	25	Rated Loads Not Developed	7,900	3,600
2	50		15,850	7,200
3	75		22,950	10,400
4	100		30,600	13,900
5	125		38,200	17,350
6	150		45,850	20,800

NOTES:
(1) Class 7 means rated loads are based on a stuffer weave construction webbing possessing a minimum certified tensile strength of 9,800 lb/in. width (67 500 kPa).
(2) The rated loads for Type V slings are based on untapered slings. Folding or bunching which occurs when used with shackles, hooks, or other applications, will reduce the rated load. Consult the manufacturer.
(3) The rated load, in choker hitch, of single leg slings shall be a maximum of 80% of the vertical hitch rated load as shown in Table 22.

TABLE 23 (c)
RATED LOAD CHARTS — SINGLE LEG SLINGS
(Design Factor = 5)
Class 5 [Notes (1) and (3)]
Vertical Hitch Rating — 4 Ply Slings

Width		Types I, II, III, IV [Note (2)]		
in.	mm	lb	kg	Type V
1	25	3,800	1,750	Rated Loads Not Developed
1¾	44	6,650	3,000	
2	50	7,600	3,450	
3	75	11,400	5,200	
4	100	14,150	6,400	
5	125	17,700	8,050	
6	150	21,200	9,600	

NOTES:
(1) Class 5 means rated loads are based on a stuffer weave construction webbing possessing a minimum certified tensile strength of 6,800 lb/in. width (47 000 kPa).
(2) See Fig. 7. (For Type VI, consult the manufacturer for rated loads.)
(3) The rated load, in choker hitch, of single leg slings shall be a maximum of 80% of the vertical hitch rated load as shown in Table 23.

TABLE 24 (c)
RATED LOAD CHARTS — SINGLE LEG SLINGS
(Design Factor = 5)
Class 7 [Notes (1) and (3)]
Vertical Hitch Rating — 4 Ply Slings

Width		Types I, II, III, IV [Note (2)]		
in.	mm	lb	kg	Type V
1	25	5,500	2,500	Rated Loads Not Developed
2	50	11,000	5,000	
3	75	16,450	7,450	
4	100	20,400	9,250	
5	125	25,500	11,550	
6	150	30,600	13,900	

NOTES:
(1) Class 7 means rated loads are based on a stuffer weave construction webbing possessing a minimum certified tensile strength of 9,800 lb/in. width (67 500 kPa).
(2) See Fig. 7. (For Type VI, consult the manufacturer for rated loads.)
(3) The rated load, in choker hitch, of single leg slings shall be a maximum of 80% of the vertical hitch rated load as shown in Table 24.

CHAPTER 9-6 (b)
Synthetic Roundslings — Selection, Use, and Maintenance

Section 9-6.0: Scope

This Chapter applies to endless slings comprised of load bearing core(s) made of multifilament synthetic yarn(s), enclosed in a protective cover(s), for lifting purposes.

Section 9-6.1: Materials and Configurations

9-6.1.1 Core. Yarn(s) shall be of a synthetic fiber, wound together on a plurality of turns for even distribution of the load.

9-6.1.2 Cover. In chemically active environments the cover shall be the same type yarn as the load bearing core. In other environments the cover and core should be the same type yarn. If the cover and core are different yarn types, follow the recommendations of the manufacturer or a qualified person. Stitching, if used, should be of the type to prevent unraveling.

9-6.1.3 Thread. When the core and cover are the same yarn type, the thread shall be of that yarn type. When the core and cover are of a different yarn type, the thread should be of the same yarn type as the core.

9-6.1.4 Coatings. Finishes and coatings shall be compatible with material of the core, cover, and thread, and not impair the performance of the roundsling.

(c) **9-6.1.5 Configurations.** Some basic roundsling configurations are illustrated in Fig. 13. Roundslings of other configurations shall be used in accordance with the recommendations of the manufacturer or a qualified person.

Section 9-6.2: Design Factor

The design factor for roundslings shall be a minimum of five (5).

Section 9-6.3: Rated Load

9-6.3.1 The term *rated capacity* is commonly used to describe *rated load*.

9-6.3.2 Rated loads for single leg polyester roundslings shall conform to the values shown in Table 25. The roundsling shall not be used at a load greater than that shown in Table 25. (c)

Other polyester roundslings or roundslings made from other materials shall be used in accordance with the recommendations of the manufacturer or a qualified person.

9-6.3.3 The following equation shall be applicable to determine rated loads for bridle roundslings, for multiple leg roundslings, for basket hitches where both legs are not vertical, and for consideration of the angle between multiple leg basket hitch roundslings (see Table 25 and Fig. 14): (c)

rated load (resultant) = single leg vertical hitch rated load × number of legs × sine of minimum horizontal angle

Sines
30 deg. — 0.500
45 deg. — 0.707
60 deg. — 0.866

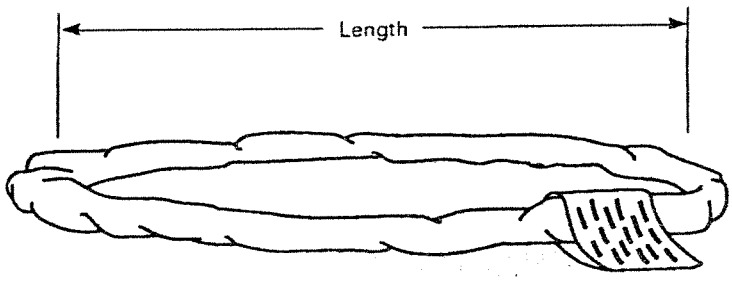
9-6.3.4 Horizontal angles less than 30 deg. should not be used (see Fig. 14). (c)

Section 9-6.4: Proof Test

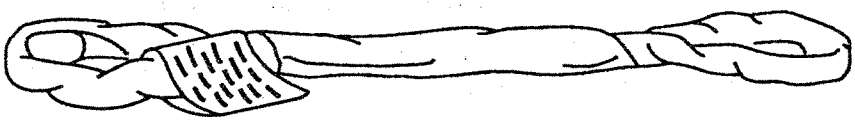
When specified by the purchaser, roundslings of all types shall be proof tested.

(a) The proof load for roundslings shall be two times the vertical hitch rated load. (c)

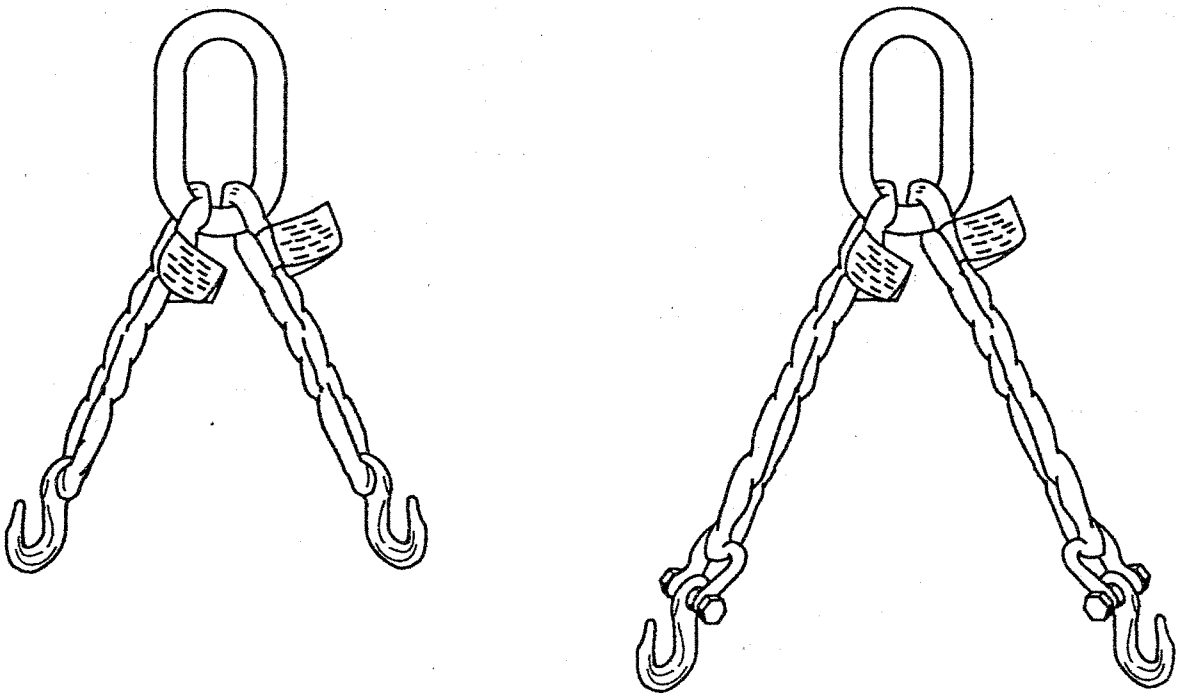
(b) The proof load for multiple leg roundslings shall be applied to the individual legs and shall be two times the vertical hitch rated load of a single leg roundsling. (c)



Endless Roundsling



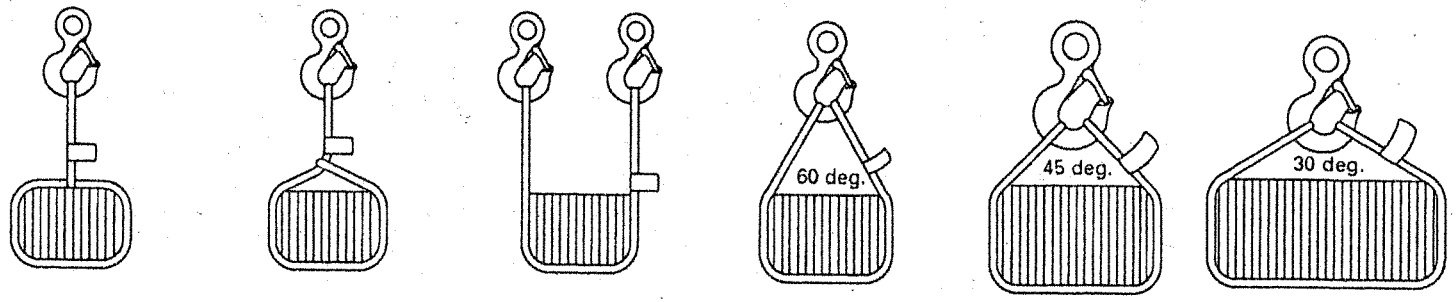
Endless Roundsling With Center Cover (Eye and Eye)



Endless Roundsling With Fittings

FIG. 13 SYNTHETIC ROUNDSLING CONFIGURATIONS (c)

(c) TABLE 25 RATED LOAD[1] (RATED CAPACITY) FOR SINGLE LEG POLYESTER ROUNDSLINGS — ENDLESS AND EYE & EYE TYPE
(Design Factor = 5)



Size [Note (2)]	Vertical Hitch [Note (3)]		Choker Hitch		Vertical Basket Hitch		60 deg. Basket Hitch		45 deg. Basket Hitch		30 deg. Basket Hitch	
	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
1	2,600	1,200	2,100	950	5,200	2,350	4,500	2,050	3,700	1,700	2,600	1,200
2	5,300	2,400	4,200	1,900	10,600	4,800	9,200	4,150	7,500	3,400	5,300	2,400
3	8,400	3,800	6,700	3,050	16,800	7,600	14,500	6,600	11,900	5,400	8,400	3,800
4	10,600	4,800	8,500	3,850	21,200	9,600	18,400	8,350	15,000	6,800	10,600	4,800
5	13,200	6,000	10,600	4,800	26,400	11,950	22,900	10,400	18,700	8,500	13,200	6,000
6	16,800	7,600	13,400	6,100	33,600	15,250	29,100	13,200	23,800	10,800	16,800	7,600
7	21,200	9,600	17,000	7,700	42,400	19,250	36,700	16,650	30,000	13,600	21,200	9,600
8	25,000	11,350	20,000	9,050	50,000	22,700	43,300	19,650	35,400	16,050	25,000	11,350
9	31,000	14,050	24,800	11,250	62,000	28,100	53,700	24,350	43,800	19,850	31,000	14,050
10	40,000	18,150	32,000	14,500	80,000	36,300	69,300	31,450	56,600	25,650	40,000	18,150
11	53,000	24,050	42,400	19,250	106,000	48,050	91,800	41,650	74,900	33,950	53,000	24,050
12	66,000	29,950	52,800	23,950	132,000	59,850	114,300	51,850	93,300	42,300	66,000	29,950
13	90,000	40,800	72,000	32,650	180,000	81,650	155,900	70,700	127,300	57,750	90,000	40,800

NOTES:
(1) See para. 9-6.3.1.
(2) Roundslings are identified by the vertical rated load shown on the tag. The Size Numbers in this column have been adopted by the Web Sling and Tiedown Association to describe certain polyester roundslings. They are included for reference only. Other polyester roundslings may have different vertical rated loads.
(3) Color guidelines for polyester roundsling covers are widely used to indicate the vertical rated load of roundslings; however, this is not followed by some manufacturers. Always select and use roundslings by the rated load as shown on the tag, never by color.

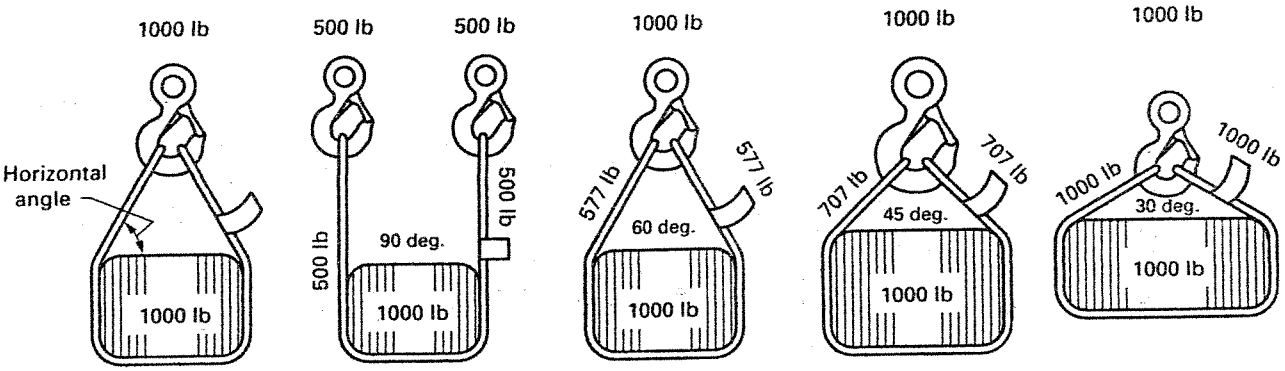


FIG. 14 SLING ANGLES (c)

(c) **Section 9-6.5: Roundsling Identification**

9-6.5.1 Marking Requirements. Each sling shall be marked to show:

(a) name or trademark of manufacturer;

(b) manufacturer's code or stock number;

(c) rated load for types of hitch(es), and the angle upon which it is based;

(d) core material; and

(e) cover material, if different from core material.

9-6.5.2 Sling identification shall be done by the sling manufacturer.

9-6.5.3 Maintenance of Sling Identification. Sling identification should be maintained by the user so as to be legible during the life of the sling.

Section 9-6.6: Effects of Environment

9-6.6.1 Chemically Active Environments. Chemically active environments, such as acids and caustics can effect the strength of roundslings. The roundsling manufacturer should be consulted before roundslings are used in chemically active environments.

9-6.6.2 Temperature. Polyester roundslings shall not be used at temperatures in excess of 194°F (90°C) or at temperatures below –40°F (–40°C). Some synthetic yarns do not retain their published breaking strength above 140°F (60°C). The roundsling manufacturer should be consulted for the temperature range of roundslings made from other synthetic yarn.

Section 9-6.7: Fittings

(a) Fittings shall be compatible with the mechanical and environmental requirements imposed on the roundsling.

(b) Fittings shall have sufficient strength to sustain twice the rated load of the roundsling without permanent deformation and shall have a minimum breaking strength equal to five times the rated load of the roundsling.

(c) All fitting surfaces shall be smoothly finished and sharp edges removed so as not to cause damage to the roundsling.

(d) Previously used or welded fittings shall be proof tested to two times the vertical rated load of the roundsling.

(e) Aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of caustics, or acids are present.

(f) The eye opening in a fitting shall be the proper shape and size so that the fitting will seat properly in the hook or other attachment.

(g) The diameter and width of the bearing surface of the fitting can affect the strength of the roundsling. The roundsling manufacturer's recommendations should be followed when fittings are used with roundslings.

Section 9-6.8: Inspection Removal and Repair

9-6.8.1 Inspection Classification

(a) Initial Inspection. Prior to use, all new, altered, modified, or repaired roundslings shall be inspected by a designated person to verify compliance with the applicable provisions in this Volume.

(b) Regular Inspection. Procedure for roundslings in regular service is divided into two general classifications based upon the interval at which inspection should be performed. The intervals in turn are dependent upon the degree of exposure of the roundsling components to wear and deterioration. The two general classifications are herein designated as *frequent* and *periodic*, with respective intervals between inspections as defined below.

(1) Frequent Inspection. Visual examinations by

the user or other designated personnel (records not required).

(a) Normal service — daily when in use

(b) Severe service — each use

(c) Special or infrequent service — as recommended by a qualified person before and after each occurrence

(2) Periodic Inspection. Visual inspection by a designated person making a record of the inspection or of apparent conditions to provide the basis for a continuing evaluation.

(a) Normal service — daily when in use

(b) Severe service — each use

(c) Special or infrequent service — as recommended by a qualified person before and after each occurrence

9-6.8.2 Inspection Records. Written inspection records utilizing the identification for each roundsling as established by the user should be kept on file. These records should show a description of the new roundsling and its condition on each periodic inspection.

9-6.8.3 Frequent Inspection. Roundslings shall be inspected for damage at intervals as defined in para. 9-6.8.1(b)(1). In addition, visual observations should be conducted during regular service for any damage that appears between regular inspections. Any conditions such as listed in para. 9-6.8.5 shall cause the roundsling to be set aside for periodic inspection.

9-6.8.4 Periodic Inspection. Complete inspections of the roundslings shall be performed at intervals as defined in para. 9-6.8.1(b)(2). Any conditions such as listed in para. 9-6.8.5 shall be examined and determination made as to whether they constitute a hazard.

9-6.8.5 Removal Criteria. A roundsling shall be removed from service if damage such as the following is visible:

(a) missing or illegible roundsling identification (see Section 9-6.5);

(b) melting or charring of any part of the roundsling or fittings including damage from weld spatter;

(c) holes, tears, cuts, abrasive wear, or snags that expose the core yarns of the roundsling;

(d) broken or worn stitching in the cover which exposes the core yarns;

(e) fittings when damaged, stretched, cracked, worn, pitted, or distorted in any way;

(f) roundslings that are knotted;

(g) other conditions including visible damage that cause doubt as to the continued use of the roundsling.

9-6.8.6 Repairs

(a) Temporary repairs of either roundslings or fittings shall not be permitted.

(b) There shall be no repairs of load bearing yarns or fittings.

(c) Repairs to protective covers shall be done only by a roundsling manufacturer or a qualified person.

(d) When repaired, a roundsling shall be marked to identify the repair agent.

(e) Repaired roundslings shall be proof tested to two times the vertical rated load before being put back into service.

Section 9-6.9: Operating Practices

(a) Roundslings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with Sections 9-6.3 and 9-6.6.

(b) The weight of the load shall not exceed the rated load of the roundsling. Known dynamic loading shall be considered when determining the rated load requirement.

(c) Roundslings shall be shortened or otherwise adjusted only by methods approved by the roundsling manufacturer.

(d) Roundslings that appear to be damaged shall not be used unless inspected and accepted as usable under Section 9-6.8.

(e) Roundslings shall be hitched in a manner providing control of the load.

(f) Sharp corners in contact with the roundsling should be padded with protective material of sufficient strength to minimize damage to the roundsling.

(g) All portions of the human body shall be kept from between the roundsling and the load, and from between the roundsling and the crane hook or hoist hook. **(c)**

(h) Personnel should never stand in line with or next to a roundsling that is under tension.

(i) Personnel shall stand clear of the suspended load.

(j) Personnel shall not ride the roundsling.

(k) Shock loading should be avoided.

(l) Loads should not be rested on roundslings. Roundslings shall not be pulled from under a load if the load is resting on the roundsling.

(m) Roundslings should not be stored in an area where they may be subjected to mechanical, chemical, or ultraviolet damage, or where the temperature may be elevated; refer to Section 9-6.6.

(n) Load applied to the hook shall be centered in

the base (bowl) of the hook to prevent tip loading on the hook.

(o) During lifting, with or without load, personnel shall be alert for possible snagging.

(p) In a basket hitch, the load should be balanced to prevent slippage.

(q) When using a basket hitch, the legs of the roundsling should contain or support the load from the sides above the center of gravity so that the load remains under control.

(r) Roundslings shall be long enough so that the rated load is adequate when the angle of the legs is taken into consideration; see para. 9-6.3.3.

(s) Roundslings should not be dragged on the floor or over an abrasive surface.

(t) If extreme temperatures are involved, the guidance in Section 9-6.6 shall be followed.

(u) Roundslings shall not be constricted, bunched, or pinched by the load, hook, or any fitting.

(v) Roundslings shall not be used as bridles on suspended personnel platforms.

(w) For multiple leg roundslings used with nonsymmetrical loads, an analysis should be performed by a qualified person to prevent overloading of any leg.

ASME B30.9 INTERPRETATIONS

Replies to Technical Inquiries
March 1997 – January 1999

FOREWORD

This publication includes all of the written replies issued between the indicated dates by the Secretary, speaking for the ASME B30 Committee, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, to inquiries concerning interpretations of technical aspects of ASME B30.9, Slings.

These replies are taken verbatim from the original letters, except for a few typographical corrections and some minor editorial corrections made for the purpose of improved clarity. In some few instances, a review of the interpretations revealed a need for corrections of a technical nature: in these cases a corrected interpretation immediately follows the original reply.

These interpretations were prepared in accordance with the accredited ASME procedures. ASME procedures provide for reconsideration of these interpretations when or if additional information is available which the inquirer believes might affect the interpretation. Further, persons aggrieved by this interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Interpretation: 9-20

Subject: ASME B30.6-1995, Derricks and ASME B30.9-1996, Slings

Date Issued: December 23, 1997

Question (1): Is an apparatus held at its foundation by a brace, the brace held either on the surface of the ground and/or below the ground, a derrick as defined in Section 6-0.2.1? See Attachment 1.

Reply (1): No. The device portrayed does not fall under the scope of the B30 Standard.

Question (2): In moving the load, if as the derrick releases the load for a free fall there is slack in the cable(s) securing the load (there is a lack of smooth transition in the arc of the radius of the cable), is this in violation of the Standards?

Reply (2): Since Question (1) is beyond the scope of the B30 Standard, this question can not be responded to.

Question (3): Is an assembly (see Attachment 2) which includes a harness and support straps connected to a ring at the end of a lifting mechanism a sling as defined in Section 9-0.2? By way of background, this assembly (Attachment 2) is connected to two cables to an A-frame tower, and the load is lifted by a third cable connected to a separate lift tower (see Attachment 1).

Reply (3): Since Question (1) is beyond the scope of the B30 Standard, this question can not be responded to.

Interpretation: 9-21

Subject: ASME B30.9-1996, Slings

Date Issued: January 13, 1999

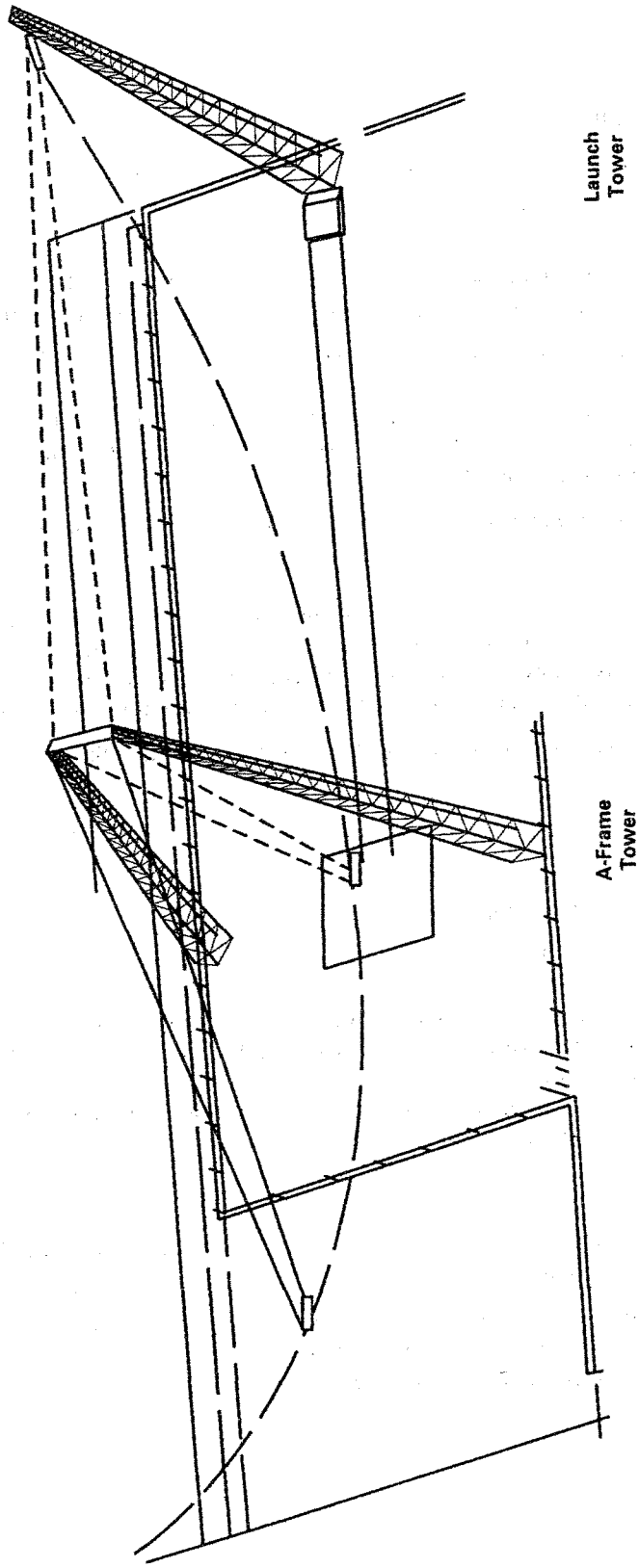
Question (1): Paragraph 9-2.1.2(a) states: "Slings made of rope with 6 × 19 and 6 × 37 classification, and cable laid slings shall have a minimum clear length of rope 10 times the rope diameter between splices, sleeves, or end fittings."

Does the minimum clear length of wire rope requirement of 10 times the rope diameter apply to turn-back eye slings constructed with 6 × 37 wire rope?

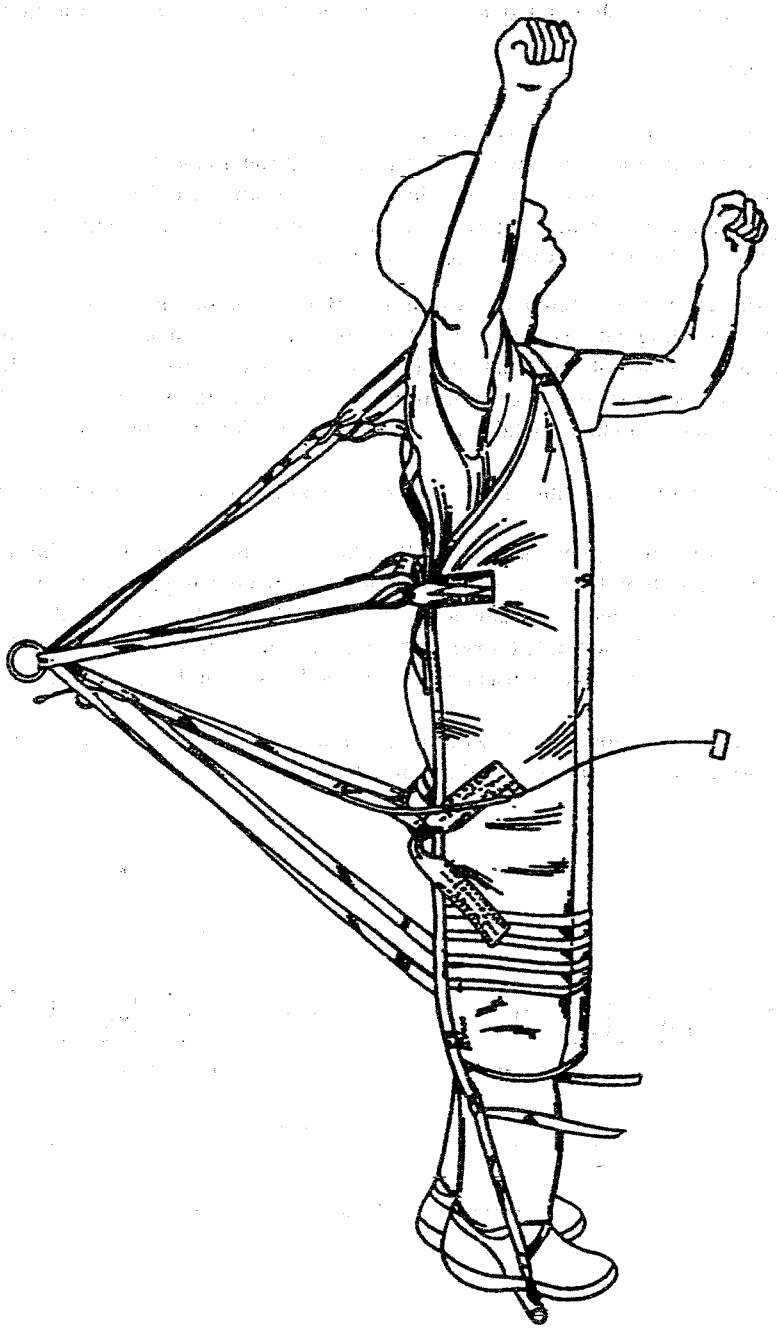
Reply (1): Yes.

Question (2): If the answer to Question (1) is yes, where should the clear length be measured from if a double swage is used to form the turn-back eye?

Reply (2): The minimum clear length of wire rope is measured between the body side of the bases of the final terminating splice or end fitting. In your schematic, the measurement of dimension B is the value required in determining the clear length of rope.



ATTACHMENT 1



ATTACHMENT 2

Interpretation: 9-22

Subject: ASME B30.9-1996, Slings

Date Issued: January 15, 1999

Question: The equation given in para. 9-2.3(d) to determine the rated loads for wire rope slings configured in a bridle or basket arrangement is as follows:

rated load = single leg sling rated load[1] × number of legs × sine of minimum horizontal angle

[1]Tables 3 through 9

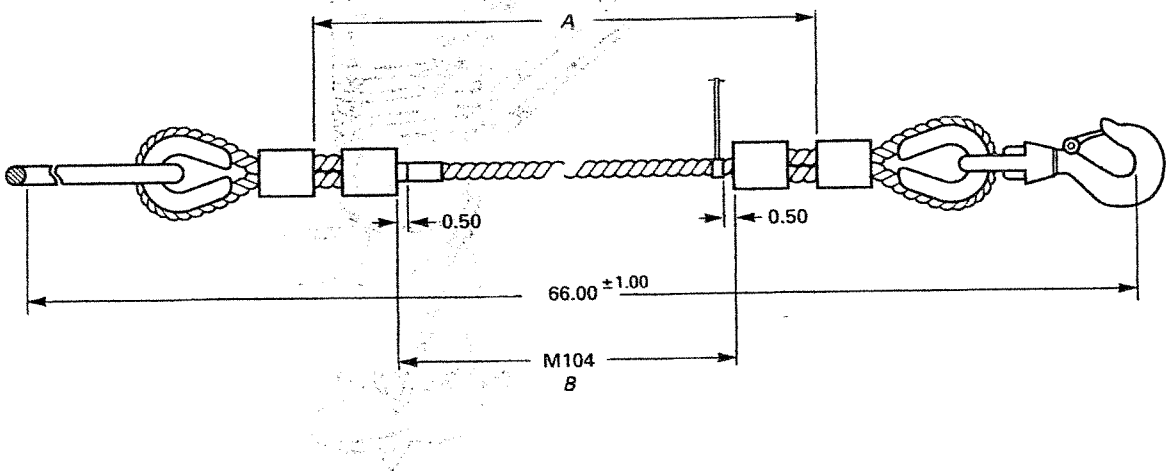
In some industries, when using a general purpose 4-leg wire rope sling, the practice is to base the strength of the configuration upon two legs. The assumption made for not using all four legs is that the load may be carried by only two legs while the remaining two legs serve to "balance" the load. Does the sling's design factor account for any uncertainty in the distribution of load among the legs of a general purpose 4-leg wire rope sling configuration?

Reply: The design factor referenced within the B30.9 volume is used by the sling manufacturer when producing the sling and is not relevant to the end user when selecting the sling. It is in the B30.9 volume as a point of information. The design factors for slings are based upon years of satisfactory service established by organizations and manufacturers and adopted by the B30 Main Committee. They were adopted to take into account consideration factors such as dynamic loading, wear, and corrosion.

The distribution of the load among the legs is a rigging question, not one regarding the rated load calculation.

The rated load equations given in the B30.9 volume are based upon the characteristic properties of the sling material, and therefore, the equation will vary from Chapter to Chapter. In addressing your specific use of wire rope, the requirement of para. 9-2.3(d) indicates that the rated load for a 4-leg sling is 4 times the single leg rated load corrected for the minimum horizontal angle or for special nonsymmetrical loading. Nonsymmetrical loads are addressed under para. 9-2.9(aa) and states:

"(aa) for multiple leg slings used with nonsymmetrical loads, an analysis by a qualified person should be performed to prevent overloading of any leg."



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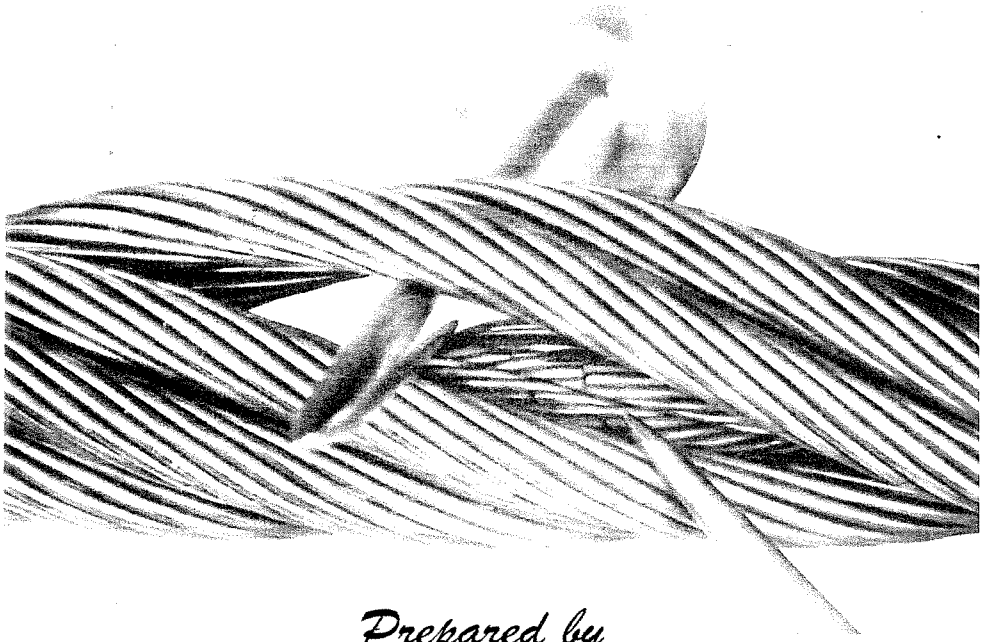
Sling & Rigging Hardware Inspection



Prepared by

SLINGMAX® RIGGING SOLUTIONS

Name: _____

SLINGMAX RIGGING SOLUTIONS

Table of Contents

Preface

To be a quality inspector of slings and rigging hardware the inspector must be capable of more than recognizing when it is time to remove rigging gear from service. The inspector should be able to resolve reoccurring problems seen during inspection and be capable of making recommendations that will result in using the sling or rigging hardware type that will make rigging safer and more efficient. This course and handout material is designed to help the inspector make these types of recommendations.

"Sling and Rigging Hardware Inspection" course inspection processes are based on OSHA and ASME Standards, manufacturer's recommendations and good rigging and inspection practices used throughout the crane and rigging industry.

Objectives

Terminal:

At the completion of "Sling and Rigging Hardware Inspection" training the participant will be able to identify sling and rigging hardware types, their applications, defects, failures and their probable causes.

Enabling:

1. Identify wire rope constructions used to fabricate wire rope slings.
2. Identify wire rope component parts
3. Identify inspection types and requirements
4. Know the proof testing requirements for wire rope, alloy chain, metal mesh, synthetic web and synthetic round sling.
5. Identify marking requirements and inspection/removal criteria for wire rope, alloy chain, metal mesh, synthetic web and synthetic round sling.
6. Identify marking requirements and inspection/removal criteria for shackles, G-Links™, eye bolts, swivel hoist rings, rigging hooks, turnbuckles and wire rope clips.

References

1. CFR1926.251
2. CFR1910.184
3. ASME B30.9
4. ASME B30.10
5. ASTM F 541
6. RRC 271D
7. Slingmax® Rigging Solutions
8. The Crosby® Group
9. Campbell® Chain
10. Actek® Manufacturing and Engineering
11. Cambridge Wire Cloth company
12. Web & Tie Down Association

How Much Does Rigging Gear Cost?

For many years companies have been seeking competitive pricing and purchasing rigging gear by making simple phone calls to potential suppliers and asking the price of products that they have been buying for years; Example: 20 - 1" x 20' wire rope slings. This type of purchase is made several times in the course of twelve months. Several improvements can be made to this process that will save companies money and directly affect their bottom line. For example, when determining the actual cost of total rigging gear expenditures, such things as workers compensation claims associated with using these tools and down time must be taken into consideration.

Before we get to the suggested improvements to the purchasing process, let us discuss some of the negative aspects of purchasing rigging on bidding price only. First, as the bidding process continues and the prices get lower, suppliers will find ways to cheapen the product by using different materials and processes which may result in a reduction in quality and safety. This is a detriment to the end user. Second, as the quality of the products deteriorates, it will not last as long, requiring the need for purchasing more often and/or spend more time using what you have. Third, in most cases there is no way to identify the manufacturer of many products in the event of an accident. In any event, the actual overall cost of the, so called, least expensive products actually becomes more. Fourth, this type of ritual buying process precludes the purchase of new and improved products, because there is no place in the chain to introduce creative technology that could increase productivity, safety and profits.

Our suggestions for improving the process which would result in less money spent on rigging gear are as follows: First and foremost, those responsible for selecting and purchasing rigging gear should have thorough training in the products they are buying from manufacturing to end use. Testing capability, insurance, raw materials, personnel skills, inventory, equipment, tracing of materials, quality programs, product knowledge, and a variety of other comparisons that would lead to the very best suppliers should be evaluated. Alternative products that could lead to significant cost savings, on an annual basis, should be researched and then considered. New products may require less people, less equipment, less potential for injury and may be repairable meaning fewer repeat purchases. Field personnel should be trained in the safe use of rigging gear and proper inspection technique. The selection of a single very best supplier will result in lower purchasing costs, allow product tracing and result in a higher quality product in the hands of the riggers. If free inspection and training programs are part of the supplier's service, then the benefits to the purchaser's company would be measurable and significant.

It is not enough to purchase the same rigging gear over and over at the lowest price. It makes sense to pay less for better quality, but this cannot be achieved by making a simple phone call. These calls only result in purchasing more of the same at lower cost and lower quality.

After a year of using the highest quality supplier with rigging training and inspection programs, add up the cost of rigging gear, down time and workers compensation claims. Companies will find they have cost savings and happier employees. Every time a request comes in for rigging only one phone call needs to be made!

INSPECTIONS

Inspection Types

CFR1910.184(e)(3); CFR1926.251(b)(6); ASME B30.9-1.9; B30.9-2.9; B30.9-3.9; B30.9-5.9; B30.9-6.9

Initial Inspection *ASME B30.9-1.9.1; B30.9-2.9.1; B30.9-3.9.1; B30.9-5.9.1; B30.9-6.9.1*

Before using any new or repaired sling, it shall be inspected to ensure that the correct sling is being used as well as to determine that the sling meets the proper regulatory requirements.

Frequent Inspection (Pre-use) *ASME B30.9-1.9.2; B30.9-2.9.2; B30.9-3.9.2; B30.9-5.9.2; B30.9-6.9.2*

All slings shall be visually inspected by the person handling the sling each day they are used. These visual observations should be concerned with discovering gross damage, which may be an immediate hazzard.

Periodic Inspection *ASME B30.9-1.9.3; B30.9-2.9.3; B30.9-3.9.3; B30.9-5.9.3; B30.9-6.9.3*

A periodic inspection shall be performed by a designated person on a regular basis with the frequency of inspection based on:

- frequency of sling use,
- severity of service conditions,
- nature of lifts being made,
- experience gained in the service life of slings used in similar circumstances.

Inspections shall be made at least annually and shall include a record of the inspection or of apparent conditions to provide the basis for a continuing evaluation. Inspections shall be conducted on the entire length of the sling including splices, end attachments and fittings. Deterioration that would result in loss of original strength shall be observed and determination made whether further use would constitute a hazard.

PROOF TESTING

29 CFR 29 1910.184

"Proof test" is a nondestructive tension test performed by the sling manufacturer or an equivalent entity to verify construction and workmanship of a sling.

ASME B30.9

Proof Test: a nondestructive load test made to a specific multiple of the rated load of the sling.

Required Proof Testing

Crane pendants, welded chain sling assemblies and all repaired slings must be proof tested. Proof testing for welded chain shall occur after required heat treating. A certificate of test should accompany any tested product.

1) Speltered and swaged end fittings - 2 - 2.5 times Vertical Rated Capacity (VRC)
   ASME B30.9-2.6.1(a)

2) Turnback eyes, mechanical joint grommets, and endless wire rope slings - 2 times Vertical Rated Capacity (VRC)
   ASME B30.9-2.6.1(a)

3) All components of an alloy steel chain sling, either individualy or as an assembly. - 2 times rated capacity.
   ASME B30.9-1.6.1

4) Metal Mesh Slings - 2 times VRC
   ASME B30.9-3.6.1(a)

5) All repaired slings - 2 times VRC
   ASME B30.9-1.6.1; B30.9-2.6.1(b); B30.9-3.6.1(a); B30.9-5.6.1(b); B30.9-6.6.1(a)

Optional Proof Tests

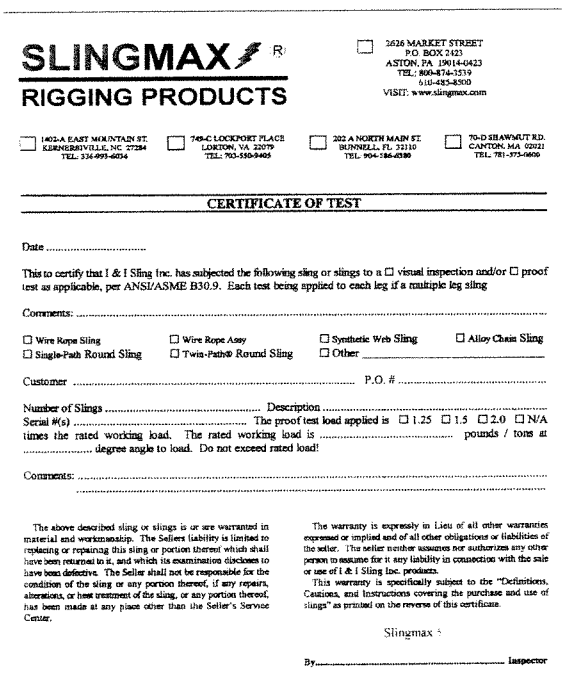
Wire rope slings, mechanical chain slings, synthetic web slings and synthetic round slings are to be tested when requested by the buyer.

1) Wire Rope Slings
   ASME B30.9-2.6.1(c)
   - Hand splice - 1- 1.25 times VRC
   - Mechanical (FE) splice - 2 times VRC

2) Mechanical Alloy Chain Slings (Complete assemblies)
   ASME B30.9-3.6.1(a)
   - 2 times VRC
   - Strongly recommend that all assemblies be proof tested.

3) Synthetic Web Slings
   ASME B30.9-5.6.1(b)
   - 2 times VRC

4) Synthetic Round Slings
   ASME B30.9-6.6.1(a)
   - 2 times VRC



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☐ 202 A NORTH MAIN ST.
BUNNELL, FL 32110
TEL: 904-586-6580

☐ 70-D SHAWMUT RD.
CANTON, MA 02021
TEL: 781-575-0600

CERTIFICATE OF TEST

Date .....

This to certify that I & I Sling Inc. has subjected the following sling or slings to a ☐ visual inspection and/or ☐ proof test as applicable, per ANSI/ASME B30.9. Each test being applied to each leg if a multiple leg sling

Comments: .....

☐ Wire Rope Sling ☐ Wire Rope Assy ☐ Synthetic Web Sling ☐ Alloy Chain Sling
☐ Single-Path Round Sling ☐ Twin-Path® Round Sling ☐ Other _____

Customer ..... P.O. # .....

Number of Slings ..... Description .....
Serial #(s) ..... The proof test load applied is ☐ 1.25 ☐ 1.5 ☐ 2.0 ☐ N/A times the rated working load. The rated working load is ..... pounds / tons at ..... degree angle to load. Do not exceed rated load!

Comments: .....
.....

The above described sling or slings is or are warranted in material and workmanship. The Sellers liability is limited to replacing or repairing this sling or portion thereof which shall have been returned to it, and which its examination discloses to have been defective. The Seller shall not be responsible for the condition of the sling or any portion thereof, if any repairs, alterations, or heat treatment of the sling, or any portion thereof, has been made at any place other than the Seller's Service Center.

The warranty is expressly in Lieu of all other warranties expressed or implied and of all other obligations or liabilities of the seller. The seller neither assumes nor authorizes any other person to assume for it any liability in connection with the sale or use of I & I Sling Inc. products.
This warranty is specifically subject to the "Definitions, Cautions, and Instructions covering the purchase and use of slings" as printed on the reverse of this certificate.

Slingmax

By..... Inspector

WIRE ROPE

Component Parts of Wire Rope

B30.9-2.0 figure 3

Wire rope consists of three basic components: *1) wires* that form the strand, *2)* multi-wire *strands* laid helical around a core and *3)* the *core*.

1) *WIRES* that form the strand:

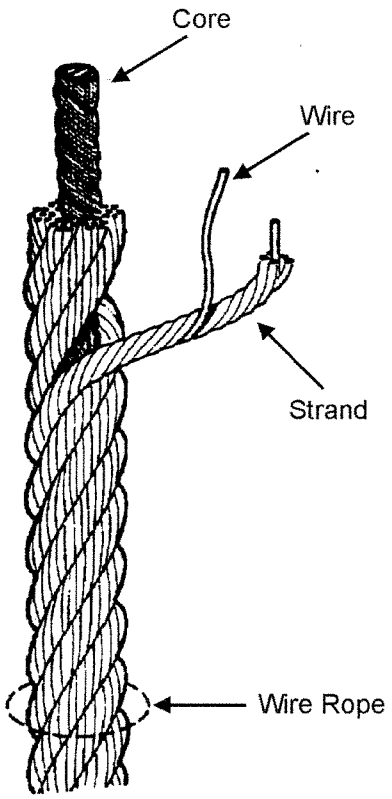
   Wire for rope is made of several materials. The most common type is high carbon steel, which is available in various grades

2) Multi-wire *STRANDS* laid helical around a core:

   Strands are made up of two or more wires, laid in any one of many specific geometric arrangements.

3) The *CORE* which is the foundation of the rope:

   The core is the foundation of the rope that provides proper support for the strands under normal bending and loading conditions. Core materials include fiber or steel.



In summary: a wire rope consists of three components: wires, strands and a core. To these may be added what is considered a fourth component: the wire rope lubricant--a factor vital to satisfactory performance of most operating ropes. The lubricant that comes on a new rope is adequate for initial storage and the early stages of the ropes working life, but it must be re-lubed as needed throughout its working life.

Wire Rope Classification

Wire ropes are classified by the number of strands as well as by the number of wires in each strand. However, these nominal classifications may or may not reflect the actual construction of the rope. Within each standard classification, ropes of the same size, grade and core have the same strengths and weights. The 6 x 7 class has one construction. The others offer several strand designs to provide a variety of operating characteristics for specific applications.

6 x 7 Classification

Ropes contain 6 strands with 3 through 14 wires per strand, with no more than 9 of which are outside wires.

6 x 19 Classification

Ropes contain 6 strands with 15 through 26 wires per strand, with no more than 12 of which are outside wires

6 x 36 Classification

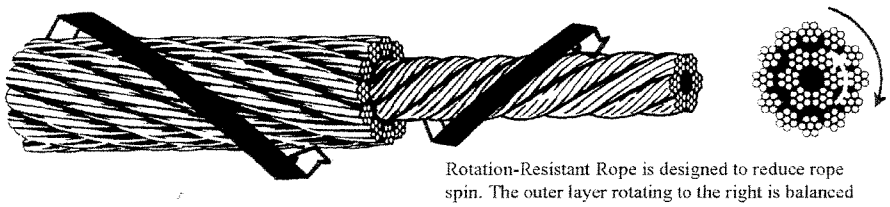
Ropes contain 6 strands with 27 through 49 wires per strand, with no more than 18 of which are outside wires.

Rotation Resistant

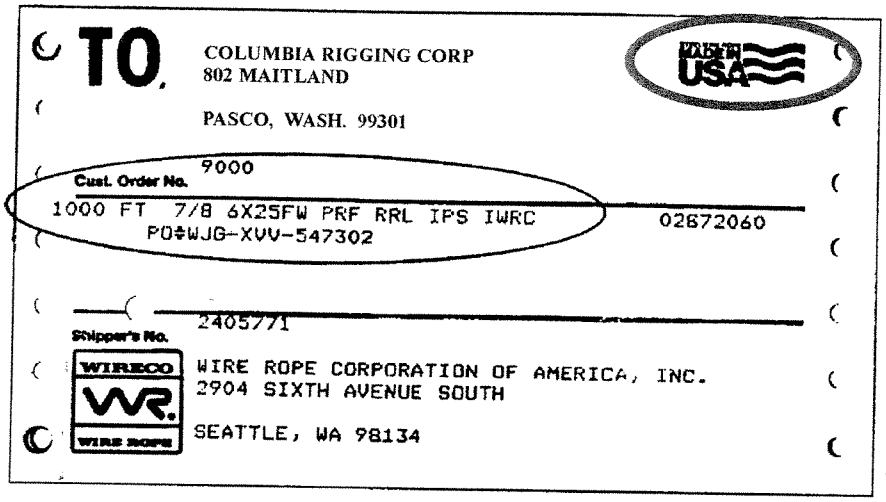
Standard rotation resistant ropes are 19 x 7, 18 x 7 and 8 x 19 constructed ropes. These ropes consist of an inner layer of strands laid in one direction covered by a layer of strands laid in the opposite direction. This has the effect of counteracting torque by reducing the tendency of the rope to rotate.

This type of wire rope as well as the high performance non-spin ropes on the market today are not recommended for fabrication of wire rope slings.

Rotation-Resistant Rope



Rotation-Resistant Rope is designed to reduce rope spin. The outer layer rotating to the right is balanced by the inner layer rotating to the left.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9000
Cust. Order No.
1000 FT 7/8 6X25FW PRF RRL IPS IWRC
PO#WJG-XVV-547302
02672060
2405771
Shipper's No.
WIRECO WR WIRE ROPE
WIRE ROPE CORPORATION OF AMERICA, INC.
2904 SIXTH AVENUE SOUTH
SEATTLE, WA 98134

Identification and Construction of Wire Rope

To effectively inspect wire rope or wire rope slings an understanding of its construction and component parts is necessary to properly identify defects and possible solutions during the inspection process.

Description of Wire Rope

1000 FT 7/8 6X25FW PRF RRL IPS IWRC

1000 FT indicates the length of the wire rope on the reel

7/8

1) 7/8" is the nominal diameter of the wire rope

   - Nominal diameter = the smallest diameter a piece of rope should be when new.
   - Rope diameters range from 1/32" to 8"

6X25

1) The 6 indicates the number of strands in a rope.

   - There can be as few as 3 strands or as many as 19 strands in a common wire rope.

2) The 25 indicates the number of wires in a strand of wire rope.

   - There can be as few as 7 wires or as many as 72 wires in a strand.

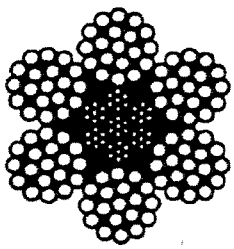
FW (filler wire)

1) FW indicates the pattern in which the wire is laid to make the strand.

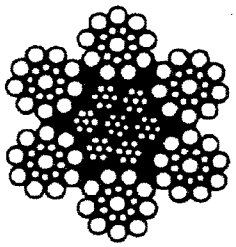
The wires in strands may be all the same size or a mixture of sizes. There are four common arrangements:

- Ordinary, where the wires are all the same size
- Seale, where larger diameter wires are used on the outside of the strand to resist abrasion and smaller wire are inside to provide some flexibility.
- Warrington, where alternate wires are large and small to combine great flexibility with resistance to abrasion.
- Filler, where very small wires fill in the valleys between the outer and inner rows of wires to provide good abrasion and fatigue resistance.

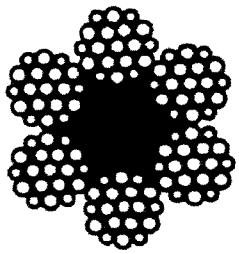
As the number of wires per strand increases, combinations of Filler, Seale, and Warrington patterns are used to provide certain characteristics.



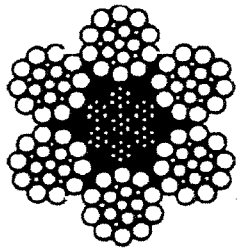
6 X 19 Ordinary



6 X 19 Seale



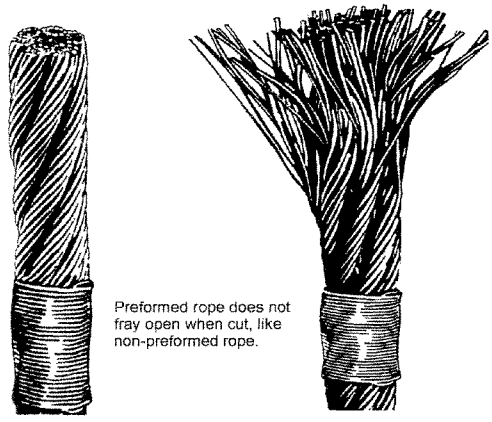
6 X 19 Warrington



6 X 25 Filler

PRF

1) PRF describes rope in which each wire and each strand is mechanically preformed into a spiral or a helical shape before it is assembled into the finished rope. This describes most of the ropes today. If a rope is not PRF (preformed) it will be a Non-PRF (non-preformed) rope.



Preformed Rope

Non-preformed Rope

RRL

1) RRL (Right Regular Lay) indicates the lay construction of the wire rope.

   If the strands in the rope are laid to the right the rope is known as a "right lay" rope and if spirally laid to the left, as a "left lay" rope.

   - If the wires in the strands are spirally laid in the opposite direction to the rope lay, the rope is classified as a "regular lay" rope.

   - If the wires in the strands are laid in the same direction as the strands themselves, the rope is known as a "lang lay" rope.
   - The difference between "regular" and "lang" is easily recognized. The outer wires in lang lay appear to run at an angle to the axis of the rope. The outer wires in regular lay appear to run in the same direction as the axis.

IPS

1) IPS (Improved Plow Steel) refers to the grade of the steel in the rope. The most common grades for slings are:

   - Improved Plow Steel (IPS)
   - Extra Improved Plow Steel (EIP or XIP)
   - Extra Extra Improved Plow Steel (EEIP or XXIP)

IWRC

1) IWRC is the description of the core of the wire rope.

   IWRC means independent wire rope core. This type of core is composed of a separate 7X7 wire rope.

   - This is a common core structure for mechanical spliced wire rope sling.

   Fiber core is generally sisal or man made synthetic fiber such as polypropylene. Identified as FC or PC.

   - This core is commonly used when making hand spliced slings.
   - Fiber core rope is not recommended for mechanical spliced slings.

2) The main purpose of the core is to support the outer strands so they can do their job. An unbalanced rope can be the end result when the core ceases to support the outer strands.

SLINGS

Slings require special attention because they are almost always subjected to severe wear, abrasion, impact loading, crushing, kinking and overloading. They also merit special attention because seemingly insignificant changes in sling angle drastically affect their loading.

Wire Rope Slings (Design Factor - 5:1 *ASME B30.9-2.4*)

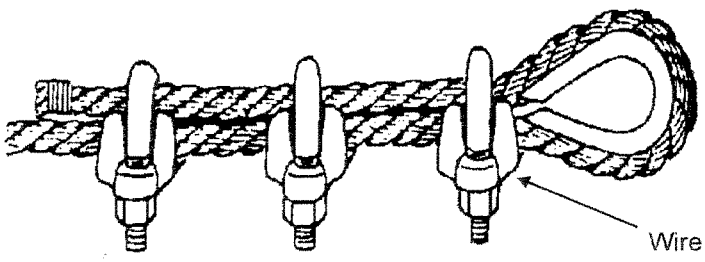
Special Considerations

1) Capacities of wire rope slings shall be specified by the manufacturer using a design factor of 5. Capacities are based on the following factors:
   ASME B30.9-2.3
   - material strength(s)
   - design factor
   - type of hitch
   - angle of loading
   - based on a D/d ratio of 20:1
   - nominal splicing and end attachment efficiency

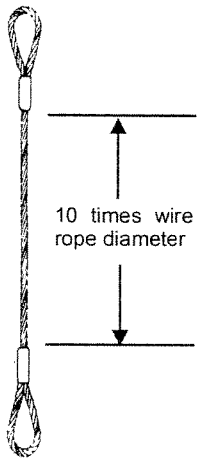
2) Rotation-resistant wire rope shall not be used to fabricate slings.
   ASME B30.9-2.2(c)

3) Wire rope clips shall not be used to fabricate wire rope slings except where the application of slings prevents the use of prefabricated slings or where the specific application is designed by a qualified person. When properly installed, slings will be rated at 80% of the rated wire rope capacity at a 5:1 design factor. Clamps shall be installed in accordance with the manufacturer's recommendations.
   ASME B30.9-2.3.1(a); B30.9-2.3.1(a)(1)

   Malleable cast iron clips shall not be used to fabricate sling.
   ASME B30.9-2.3.1(a)(2)

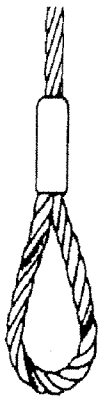


4) Slings shall be made only from new wire rope and regular lay wire rope.
ASME B30.9-2.2(a); B30.9-2.2(b)

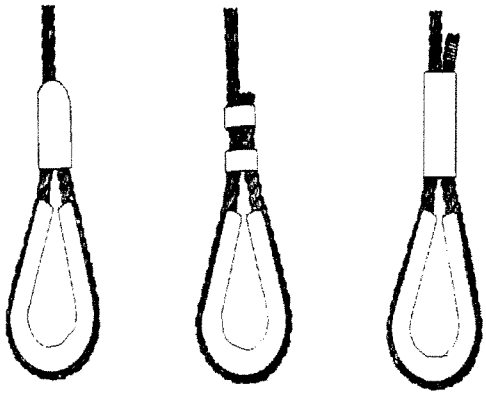


5) Slings made of rope with a 6 x19 & 6x36 construction, and cable-laid slings, shall have a minimum clear length of 10 times the rope diameter between splices, sleeves, or end fittings, unless approved by a qualified person.
ASME B30.9-2..3.2(b); CFR1910.184(f)(2)(i); CFR1926.251 (c)(4)(iv); CFR1926.251 (c)(13)(i)

6) Mechanically spliced slings can be formed by folding back the rope and securing it with one or more metal sleeves pressed over the wire rope junction. A flemished eye loop can be spliced and the metal sleeve can be pressed over the tails of the splice. The difference in appearance is shown below.

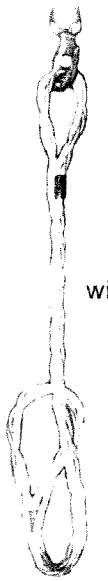


Flemish Eye



Turn or Loop Back Eye

Thimbles should be used except when their use is impractical. The thimble's purpose is to protect the inner wires of an eye in a wire rope sling from being crushed.



Multi-part wire rope sling

7) Braided slings shall have a minimum clear length of rope 40 times the component (individual) rope diameter between the loops or end fittings.
ASME B30.9-2.3.2(c); CFR1910.184 f(ii), CFR1926.252 (c)(13)(ii)

8) Grommets and endless slings shall have a minimum circumferential length of 96 times the body diameter of the grommet or endless sling.
ASME B30.9-2.3.2(d); CFR1910.184 (F)(III); cfr1926.251 (c)(13)(iii)

Proof Tests

All swaged and poured socket assemblies and tunback eye, mechanical joint grommets and endless wire rope slings shall be proof tested. *All other assemblies shall be proof tested, when specified by the purchaser using the following criteria:

ASME B30.9-2.6.19(a)

1) *Hand Tucked - proof load shall be a minimum of the rated load and shall not exceed 1.25 times rated capacity.
   ASME B30.9-2.6.2(a)(3)

2) *Wire Rope Clips - a proof load shall be a minimum of the rated capacity and shall not exceed two times the rated capacity.

3) Mechanical splices, zinc-poured, resin-poured, and swaged sockets - shall have a proof load of two times its rated vertical capacity.
   ASME B30.9-2.6.2(a)(1); B30.9-2.6.2(a)(2)

4) *Multiple Leg Slings - the proof load shall be applied to the individual legs. Any master link to which legs are connected to shall be proof loaded to two times the force applied by the combined legs.
   ASME B30.9-2.6.2(a)

Welded End Attachments

All welded load-bearing components (welded before or after assembly) in the sling shall have a design factor of 5:1 and shall be proof tested by the manufacturer or the manufacturer's agent to twice their capacity. The sling custodian shall retain proof test reports and shall make them available to authorized personnel for examination.

ASME B30.9-2.6.1(b); CFR1910.184 (f)(4)(ii); CFR1926.251 (c)(15)(ii)

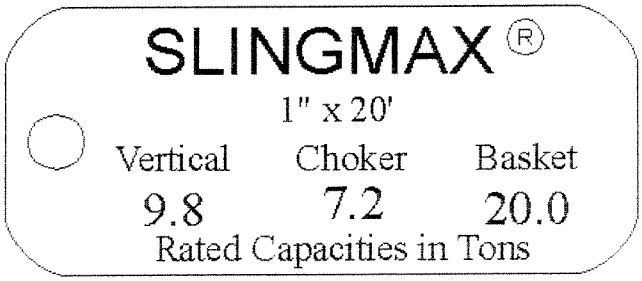
Identification

Wire rope slings shall be identified by the *1)* rated load for type of hitch(es) and angle for which it is based, *2)* diameter or size and *3)* manufacturer. This identification shall be maintained for the life of the sling.

ASME B30.9-2.7.1(a); B30.9-2.7.1(b); B30.9-2.7.1(c)

1) Initial identification shall be done by the sling manufacture.
   ASME B30.9-2.7.2

2) Maintenance of the sling's identifications should be done by the user. The identifications should be legible during the life of the sling.
   ASME B30.9-2.7.3



3) Replacement of sling identification shall be considered a repair. Additional proof testing is not required.
ASME B30.9-2..7.4

Inspection Records

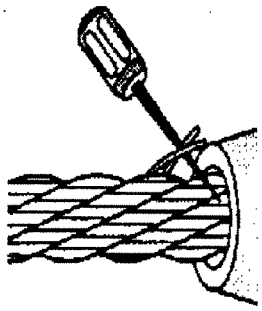
Written records of the most recent periodic inspection shall be maintained and shall include the condition of the sling.
ASME B30.9-2.9.3(c)

Inspection *(ASME B30.9-2.9.4)*

Wire rope slings shall be immediately removed from service if any of the following conditions are present:
CFR1910.251 (a)(1)

✓ Broken wires

Broken Wires



Broken Wires at End Fitting

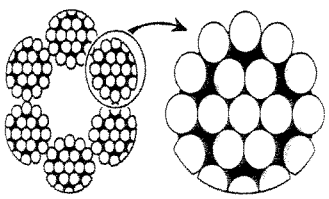
1) Strand-laid and single-part slings
ASME B30.9-2.9.4(b)(1); CFR1910.184 (f)(5)(i)

- 10 broken wires in one rope lay or 5 in one strand in one rope lay

2) Braided and cable-laid slings
ASME B30.9-2.9.4(b)(2); B30.9-2.9.4(b)(3); B30.9-2.9.4(b)(4)

- Less than eight-part braid and cable laid more than 20 broken wires per lay or one braid and no more than one broken strand per sling length.
- More than eight-part braid and cable laid more than 40 broken wires per lay or one braid and no more than one broken strand per sling length.

✓ Severe localized abrasion or scraping. 1/3 the original diameter of outside individual wires can be considered severe.
ASME B30.9-2.9.4(c); CFR1910.184 (f)(5)(ii)



✓ Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.

ASME B30.9-2.9.4(d); CFR1910.184 (f)(5)(iii)

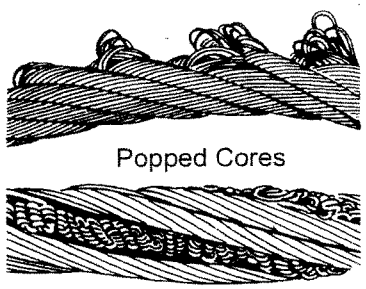
Kinking

✓ Evidence of heat damage.

ASME B30.9-2.9.4(e); CFR1910.184 (f)(5)(iv)

✓ Popped or protruding core.

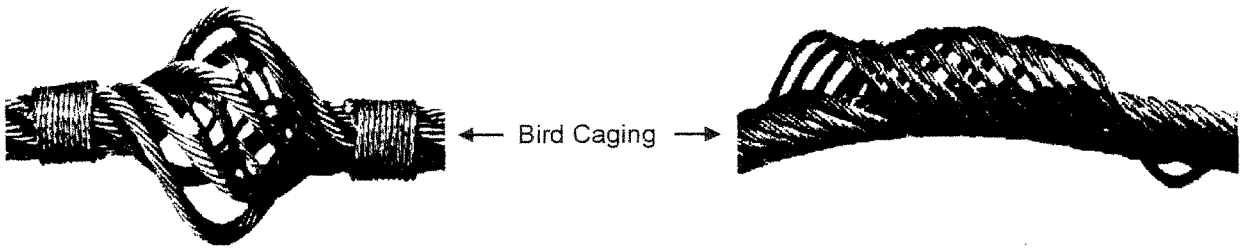
ASME B30.9-2.9.4(d); CFR1910.184 (f)(5)(iii)



Popped Cores

✓ Bird caging

ASME B30.9-2.9.4(d); CFR1910.184 (f)(5)(iii)



← Bird Caging →

✓ End attachments that are cracked, deformed, or worn to the extent that the strength of the sling is substantially affected.

ASME B30.9-2.9.4(f); CFR1910.184(f)(5)(v)

✓ Severe corrosion of the rope or end attachments.

- Pitting caused by corrosion would dictate removal from service.

ASME B30.9-2.9.4(g); CFR1910.184 (f)(5)(vii)

✓ Other conditions, including visible damage, that cause doubt as to the continued use of the sling.

ASME B30.9-2.9.4(i)

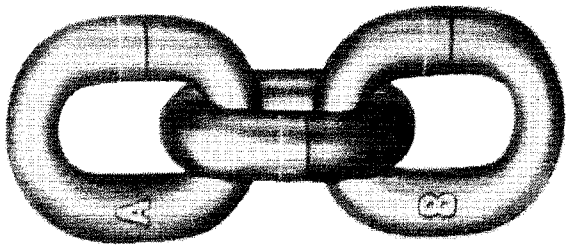
✓ Missing or illegible identification

ASME B30.9-2.9.4(a)

Alloy Steel Chain Slings (Deign Factor - 4:1 *ASME B30.9-1.4*)

General Requirements

1) Chain shall conform to the requirements of ASTM A391 / A 391M for Grade 80 and ASTM A 973 / A 973M for Grade 100 chain.
ASME B30.9-1.2.1



Not all chain is acceptable for lifting. Chain acceptable for lifting is an alloy steel. Generally Grade 80 or Grade 100. More recently Grade 120 is available in some sizes. The chain links will be marked to verify their grade.
ASME B30.9-1.3.1(a)

Chain Grades

- Grade 30 (PC, G3, G30, G27) Ornamental
- Grade 40 (HT, G4, G40, G43) Tie-down and miscellaneous use
- Grade 70 (G7, G70) Tie-down
- Grade 80 (G8, G80) Alloy chain slings
- Grade 100 (G10, G100) Alloy chain slings
- Grade 120 (G12, G120) Alloy chain slings

Proof Tests *(ASME B30.9-1.6)*

1) Prior to use, all new and repaired chain and components of alloy chain slings, either individualy or as an assembly shall be proof tested.
ASME B30.9-1.6.1

2) The proof load of single or multiple leg slings shall be applied to the individual legs and shall be twice the rated load of a single leg sling.
ASME B30.9-1.6.2(a)

3) Master links of multiple leg assemblies shall be tested as follows: Double leg assemblies - 4 times single-leg vertical hitch capacity. Triple and quadruple-leg bridle assemblies - 6 times single-leg vertical hitch capacity.
ASME B30.9-1.6.2(c) & (d)

Attachments *(ASME B30.9-1.7; CFR1910.184 (e)(2))*

1) Hooks, rings, oblong links, pear links, mechanical coupling links or other attachments shall have a rated load at least equal to that of the alloy steel chain with which it is used. In those cases where particular usage makes this impractical, the sling shall be marked with the rated load that is consistent with the least working load rating of any component.
ASME B30.9-1.5.7; CFR1910.184(e)(2)(i); CFR1926.251(b)(2)

2) Standard attachments should be of a size recommended by the sling manufacturer.
CFR1910.184(e)(2)(ii)

3) Makeshift fasteners, hooks or links shall not be used. However, nonstandard end fittings designed by a qualified engineer may be used.
ASME B30.9-1.2.2.(b); CFR1926.251(b)(3)

Safe Operating Temperatures

1) Extreme temperatures will reduce the performance of alloy chain slings. Reduction of sling capacities in temperatrues above 400°F (205°C) see ASME Table 3 on page 22 of this book.
ASME B30.9-1.8.1; CFR1910.184(e)(6)

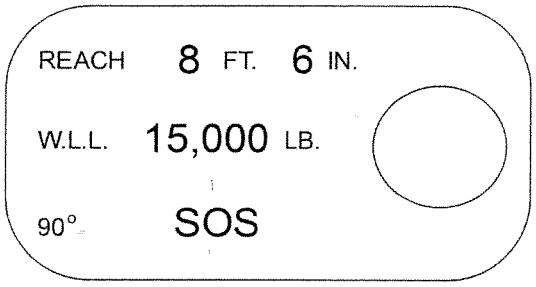
2) Alloy chain slings shall be permanently removed from service if they are heated above 1000°F.
CFR1910.184(e)(6)

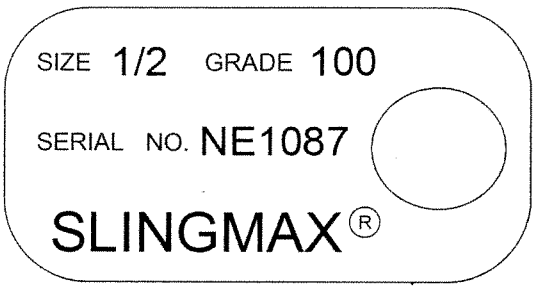
3) The chain manufacturer should be consulted when slings are to be used in temperatures below -40°F (-40°C) for grade 80 or -20°F (-29°C) for grade 100.
ASME B30.9-1.8.1

Identification ASME B30.9-1.7; CFR1910.184(e)(1); CFR1926.251(b)(1)

1) Alloy chain slings shall be labeled by the manufacturer with permanently affixed durable identification stating the following:
ASME B30.9-1.7.2
   - Nominal chain size
     ASME B30.9-1.7.1(c); CFR1910.184(e)(1)
   - Chain grade
     ASME B30.9-1.7.1(b); CFR1910.184(e)(1)
   - Rated loads for the type(s) of hitch(es) used and the angle which it is based.
     ASME B30.9-1.7.1(e); CFR1910.184(e)(1)
   - Length (reach)
     ASME B30.9-1.7.1(f); CFR1910.184(e)(1)

- Manufacturer's name or trademark
  ASME B30.9-1.7.1(a); CFR1910.184(e)(1)
- Number of legs
  ASME B30.9-1.7.1(d)





2) Sling identification should be maintained by the user so as to be legible during the life of the sling.
   ASME B30.9-1.7.3

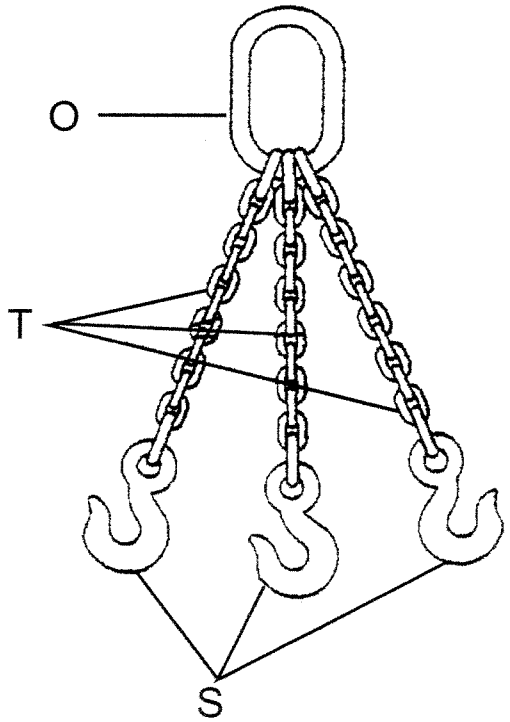
Sling Types

Though sling type identification is not required by either the OSHA or ASME standards, it is very important information that should be on the tag. Without this information neither the user or inspector can be sure exactly what fittings the sling was designed with.

First Symbol (Basic Type)
S Single leg chain sling
C Single leg with master link each end
D Double leg chain sling
T Triple leg chain sling
Q Quadruple leg chain sling

Second Symbol (Type of Master or End Link)
O Oblong master link
P Pear shaped master link

Third Symbol (Type of Hooks or End Fitting)
S Sling hook
G Grab hook
F Foundry hook
L Latch lock hook



Inspection Records

Written records of the most recent periodic inspection shall be maintained and shall include the condition of the sling.

ASME B30.9-1.9.3(c); CFR1910.184(e)(3)(ii)

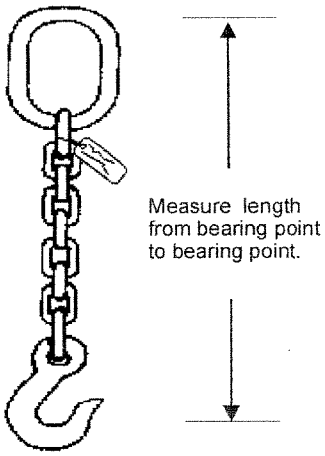
Inspection

As with other types of slings, alloy chain slings shall be visually inspected by the person using it each time it is used. Defects to look for on chain slings are as follows:

- ✓ Missing or illegible sling identification
  ASME B30.9-1.9.4(a)

- ✓ Increase in Length
  CFR1910.184(e)(3)(iii)

  Hang chain in a vertical position for preliminary inspection and to measure length. When possible, stretch chain out on level floor with all twist removed. Compare the new measured length with the length shown on the original I.D. tag. An increase in length may be due to stretch, wear or a combination of both.



- ✓ Localized stretch or wear
  ASME B30.9-1.8.2(a); CFR1910.184(e)(3)(iii)

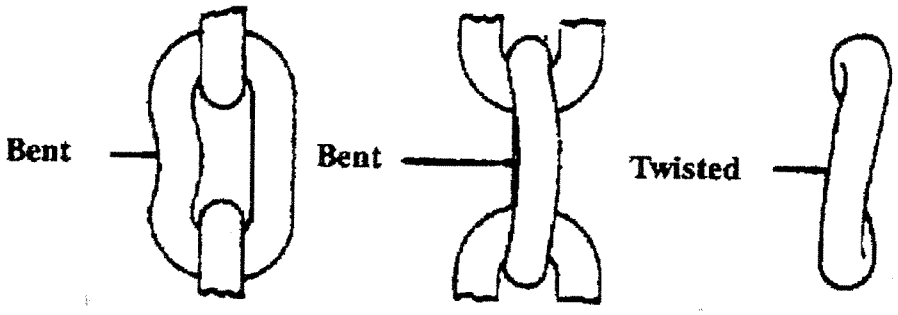
- ✓ Abrasion
  ASME B30.9-1.9.4(c)

- ✓ Excessive wear & grooving at interlink bearing points
  ASME B30.9-1.9.4(c); CFR1910.184(e)(8); CFR1926.251(b)(5)

MINIMUM ALLOWABLE THICKNESS AT ANY POINT ON A LINK

Chain Size (Inches)	Minimum allowable thickness (Inches)	Chain Size (inches)	Minimum allowable thickness (inches)
9/32	0.189	3/4	0.687
3/8	0.342	7/8	0.750
1/2	0.443	1	0.887
5/8	0.546	1-1/4	1.091

✓ Twisted and bent links
ASME B30.9-1.9.4(e)

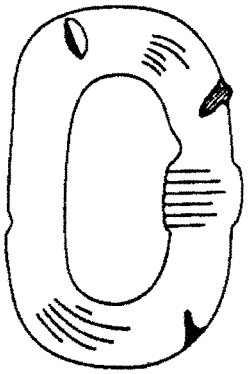


✓ Cracks or breaks
ASME B30.9-1.9.4(b)

✓ Gouges or other marks
ASME B30.9-1.9.4(c)

✓ Excessive pitting or corrosion
ASME B30.9-1.9.4(g)

✓ Burned links caused by welding stingers or splatter, buss bars or ground contacts.
ASME B30.9-1.9.4(f) & (i)



✓ Deformation or damage of master links, connecting links and end fittings
ASME B30.9-1.9.4(h); CFR1910.184(e)(9)(i)

Alloy Chain Sling Repairs

1) Repairs shall only be made by the sling manufacturer or qualified personnel.
ASME B30.9-1.9.5(a)

2) When chain repairs are made the following criteria shall be followed:
ASME B30.9-1.5

✓ Cracked, broken, or bent links or attachments shall not be repaired; they shall be replaced.
ASME B30.9-1.9.5(e)

✓ Repaired slings shall be permanently marked to identify the repairing agency.
ASME B30.9-1.9.5(b)

✓ Mechanical coupling links or carbon steel repair links shall not be used to repair broken lengths of alloy chain.
ASME B30.9-1.9.5(e)

- ✓ Mechanical coupling links shall not be used within the body of an alloy chain sling to connect two pieces of chain.
  ASME B30.901.9.5(f)

- ✓ Modifications or alterations to the sling or components shall be considered as repairs.
  ASME B30.901.9.5(g)

- ✓ All repairs shall comply with the proof test requirements.
  ASME B30.901.9.5(h)

Effect of Elevated Temperature on Rated Load of Alloy Steel Chain

Temperature		Grade 80		Grade 100	
°F	°C	Temporary reduction of rated Load while at Temperature	Permanment reduction of rated Load while at Temperature	Temporary reduction of rated Load while at Temperature	Permanment reduction of rated Load while at Temperature
Below 400	Below 204	None	None	None	None
400	204	10%	None	15%	None
500	260	15%	None	25%	5%
600	316	20%	5%	30%	15%
700	371	30%	10%	40%	20%
800	427	40%	15%	50%	25%
900	482	50%	20%	60%	30%
1000	538	60%	25%	70%	35%
Over 1000	Over 538	Note (1)	Note (1)	Note (1)	Note (1)

Note:
(1) Remove from service

Metal Mesh Slings (Design Factor - 5:1 *ASME B30.9-3.4*)

General Requirements

1) Fabric construction shall be in accordance with the table shown below.
   ASME B30.9-3.2.1 TABLE 14

2) Other materials such as stainless steel, monel, or alloy steels may be used. When mesh slings are produced from such materials, the sling manufacture shall produce specific data.
   ASME B30.9-3.2.4;

3) Rated loads shall be based on the following factors:

   - Material strengths
   - Design factor
   - Type of hitch
   - Angle of loading

   ASME B30.9-3.5.1(a), (b), (c), & (d)

FABRIC CONSTRUCTION (METAL MESH SLINGS)

	Heavy Duty	Medium Duty	Light Duty
Normal spiral turns per foot of mesh width.	35	43	59
Approximate wire size.	10 gauge (0.135 in.)	12 gauge (0.105 in.)	14 gauge (0.080 in.)
Normal cross rods per foot of fabric length.	21	30	38
Approximate size cross rods.	8 gauge (0.162)	10 gauge (0.135 in.)	14 gauge (0.080 in.)
Nominal fabric thickness.	1/2 in.	3/8 in.	5/16 in.

4) Other metal mesh materials and configurations not covered by ASME B30.9 shall be rated in accordance with the recommendation of the sling manufacturer or a qualified person..
   ASME B30.9-3.5.6

5) Slings used in pairs should be attached to a spreader beam.
   ASME B30.9-3.10.4(r)

Proof Test

1) All new metal mesh slings shall be proof tested by the sling manufacturer or qualified person to 2 times its vertical rated capacity.
   ASME B30.9-3.6.1(a); ASME B30.9-3.6.2

2) Coated slings shall be proof tested prior to coating.
   ASME B30.9-3.6.1(b)

Attachments

1) End fittings capacity shall be at least equal to the fabric to which it is attached.
   ASME B30.9-3.2.3(a)

2) Fittings shall have sufficient strength to sustain twice the rated load of the sling without visible permanent deformation.
   ASME B30.9-3.3.3(b)

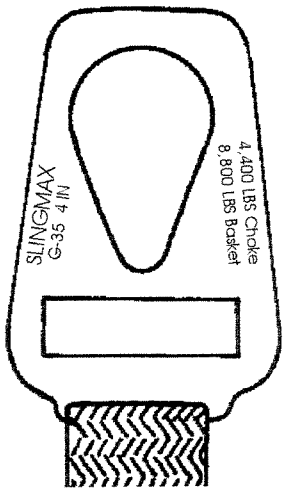
3) All surfaces of end fittings shall be cleanly finished and sharp edges removed.
   ASME B30.9-3.2.3(c)

4) When components of the sling have a lower rated load than the metal mesh with which it is being used, the sling shall be identified with a rated load consistant with the lowested load rating of any components.
   ASME B30.9-3.5.7

Identification

1) Each sling shall be marked to show the following:

   - Name or trademark of manufacturer
     ASME B30.9-3.5.1(a)
   - Rated load for the type of hitch(es), and the angle upon which it is based
     ASME B30.9-3.5.1(b)
   - Width and gauge
     ASME B30.9-3.5.1(c)



2) Sling identification shall be done by the sling manufacturer.
   ASME B30.9-3.7.2

3) The user should maintain the identification as to its legibility during the life of the sling.
   ASME B30.9-3.7.3

4) Replacement of the sling identification shall be considered a repair. Additional proof testing is not required.
ASME B30.9-3.7.4

Effect of Environment

1) Slings can be used in the following temperatures without derating the sling.

   • -20°F (-29°C) to 550°F (288°C)
   ASME B30.9-3.8.1(a)

2) Elastomerter coated slings.

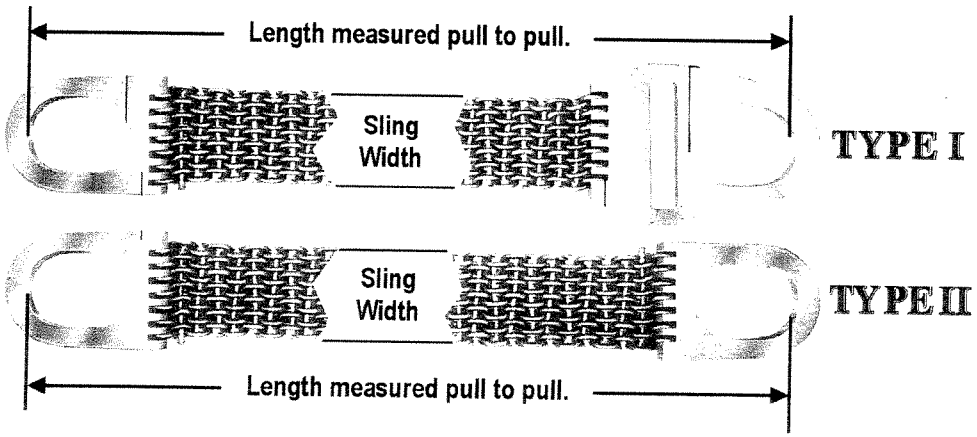
   • 0°F (-18°C) to 200°F (93°C)
   ASME B30.9-3.8.1(b)

3) For operations outside these temperature ranges or other coatings consult the manufacturer for specific data.
ASME B30.9-3.8.1(c)

4) The sling manufacturer should be consulted before slings are used in chemically active environments.
ASME B30.9-3.9.1

Sling Types

Type I metal mesh slings are designed to be used in vertical, choker, and basket hitch configurations. Where as Type II metal mesh sling are to be used in a vertical or basket hitch only.



Inspection Records

Written records of the most recent periodic inspection shal be maintained and shall include the condition of the sling.

ASME B30.9-3.9.3(c)

Inspection

As with other sling types metal mesh slings should be inspected before each use. Periodic inspections shall be conducted at least annually. Periodic inspection shall be conducted on the entire lent of the sling, including splices, end attachments, and fittings.

ASME B30.9-3.9.3(a)

Metal mesh slings shall be removed from service if damage such as the following is visible:

- ✓ Missing or illegible identification.
  ASME B30.9-3.9.4(a)
- ✓ A broken weld or broken brazed joint along the sling edge.
  ASME B30.9-3.9.4(b)
- ✓ A broken wire in the mesh.
  ASME B30.9-3.9.4(c)
- ✓ Reduction in wire diameter of 25% due to abrasion or 15% due to corrosion.
  ASME B30.9-3.9.4(d)
- ✓ Lack of flexibility due to distortion of the mesh.
  ASME B30.9-3.9.4(e)
- ✓ Distortion of the choker fitting so the depth of the slot is increased by more than 10%.
  ASME B30.9-3.9.4(f)
- ✓ Distortion of either end fitting so the width of the eye opening is decreased by more than 10%.
  ASME B30.9-3.9.4(g)
- ✓ A 15% reduction of the original cross-sectional area of metal at any point around the hook opening of end fitting.
  ASME B30.9-3.9.4(h)
- ✓ Visible distortion of either end fitting out of its plane.
  ASME B30.9-3.9.4(i)

- ✓ Cracked end fittings.
  ASME B30.9-3.9.4(j)

- ✓ Spirals locked or without free articulation.
  ASME B30.9-3.9.4(k)

- ✓ Fittings that are pitted, corroded, cracked, bent, twisted gouged, or broken.
  ASME B30.9-3.9.4(l)

- ✓ Other conditions, including visible damage, that cause doubt as to the continued use of the sling.
  ASME B30.9-3.9.4(m)

Repairs

1) Metal mesh slings shall be repaired only by a metal mesh sling manufacturer or a qualified person.
   ASME B30.9-3.9.5(a)

2) Repaired slings shall be permanently marked to identify the repairing agent.
   ASME B30.9-3.9.5(b)

3) Cracked, broken, bent, or damaged metal mesh or components shall not be repaired; they shall be replaced.
   ASME B30.9-3.9.5(d)

4) All repaired mesh slings shall be proof load tested.
   ASME B30.9-3.9.5(e)

5) Modifications or alterations to the sling or components shall be considered a repair.
   ASME B30.9-3.9.5(f)

Synthetic Web Slings (Design Factor - 5:1 *ASME B30.9-5.4*)

Basic Sling Types *ASME B30.9-5. Fig. 16*

Type 1 - TC Sling

Slings with a triangle on one end & slotted triangle on the other end.

Type 2 - TT Sling

Slings with a triangle on both ends.

Type 3 - EE Sling

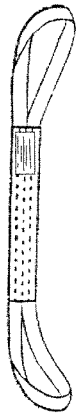
Slings with eyes on both ends, straight or tapered.

Type 4 - EE Sling

Same as a Type-3 but eyes are twisted to a right angle to the sling body.

Type 5 - EN Sling

Endless sling, sometimes refered to as a grommet sling.



Type 6 - RE Sling

Returned eye or Reversed eye sling.

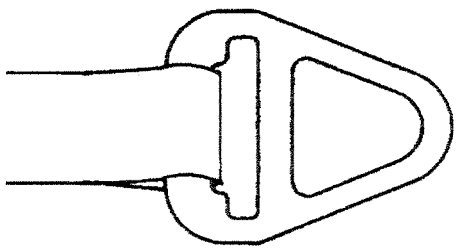
Attachments

1) Fittings shall be manufactured to ensure that the rated load shall be at least the same as the synthetic webbing sling.
ASME B30.9-5.2.4(a); CFR1926.251(e)(4)(ii)

2) End fittings shall have sufficient strength to sustain twice the rated load of the sling without permanent deformation and a minimum breaking strength equal to five times the rated capacity of the sling.
ASME B30.9-5.2.4(b); CFR1910.184(i)(3)(i); CFR1926.251(e)(4)(i)

3) Surfaces shall be cleanly finished and sharp edges removed to prevent damage to the webbing.
ASME B30.9-5.7(c); CFR1926.251(e)(4)(ii)

4) The eye opening in the fitting shall be the proper shape and size to ensure that the fitting will seat properly in the hook or other attachment.
ASME B30.9-5.10.1(g); CFR1910.184(i)(3)(ii)



End Fitting

Identification

Synthetic web slings shall be labeled by the manufacturer with a permanently affixed, durable identification showing the following:
ASME B30.9-5.7.1

1) Manufacturer's name or trademark.
ASME B30.9-5.7.1(a); CFR1926.251(e)(1)(i)

2) Manufacturer's code or stock number.
ASME B30.9-5.7.1(b);

3) Type of synthetic web material *(e.g., nylon, polyester).*
ASME B30.9-5.7.1(d); CFR1926.251(e)(1)(iii)

4) Rated loads for types of hitches used *(vertical, choker and basket).*
ASME B30.9-5.7.1(c); CFR1926.251(e)(1)(ii)

5) Sling identification should be maintained by the user so as to be legible during the life of the sling.
ASME B30.9-5.7.3

6) Replacement of the sling identification shall be considered a repair. Additional proof testing is not required.
ASME B30.9-5.7.4

SLINGMAX®		NYLON SLING	
TYPE	SERIAL NO.	WIDTH	LENGTH
EE2-902		2 in	10 ft
RATED CAPACITIES IN LBS.			
VERTICAL	CHOKER	BASKET	
6400 lbs.	4800 lbs.	12800 lbs.	

Synthetic Web Sling Tag

Special Considerations

1) Polyester and nylon web slings shall not be used at temperatures in excess of 180°F.
CFR1910.184(i)(7); CFR1926.251(e)(7)

2) Slings that incorporate aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of caustics or acids are present.
CFR1910.184(i)(6)(iii): CFR1926.251(e)(6)(iii)

3) Nylon web slings shall not be used where fumes, vapors, sprays, mists or liquids of acid or phenolic are present.
CFR1910.184(i)(6)(i); CFR1926.251(e)(b)(i)

4) Polyester web slings shall not be used where fumes, vapors, sprays, mists or liquids of acid or caustics are present.
CFR1910.184(i)(6)(ii); CFR1926.251(e)(6)(ii)

	Acids	Alcols	Aldehydes	Strong Alkalies	Bleaching Agents	Dry Cleaning Solvents	Ethers	Halogenated Hydrocarbons	Hydrocarbons	Ketones	Oil, Crude	Oil, Lubricating	Soaps & Detergents	Water & Saltwater	Weak Alkalis
NYLON	NO	OK	OK	OK	NO	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
POLYESTER	*	OK	NO	**	OK	OK	NO	OK	OK	OK	OK	OK	OK	OK	OK

*Disintegrated by concentrated sulfuric acid **Degraded by strong alkalis at elevated tempertatures GENERAL GUIDE ONLY

5) Synthetic web slings are not recommended where extensive exposure to sunlight or ultraviolet light is experienced.
WSTA - 2000; ASME B30.9-5.9.4(h)

6) Stitching shall be the only method to fabricate synthetic web slings. The stitching thread shall be the same yarn type as the sling webbing.
ASME B30.9-5.3.1(a)&(b); CFR1910.184(i)(4); CFR1926.251(e)(5)

7) Written inspection records, utilizing the identification for each sling as established by the user, shall be kept for all slings. These records should show a description of the new sling and its condition on each periodic inspection.
ASME B30.9-5.8.2

Proof Test

When specified by the purchaser, web slings of all types shall be proof tested as follows: *[ASME B30.9-5.6.1(b)]*

1) For single or multiple-leg slings and endless slings, each leg shall be pulled to two times the single-leg vertical rated load.
ASME B30.9-5.6.2(a) & (b)

2) Prior to intial use, all synthetic web slings incorporating previously used or welded fittings and all repaired slings shall be proof tested.
ASME B30.9-5.6.1(a)

3) Master links for multiple-leg bridles shall be tested to 2 times the total vertical rated capacity of all the sling legs combined.
ASME B30.9-5.6.1(b), (c), (d), & (e)

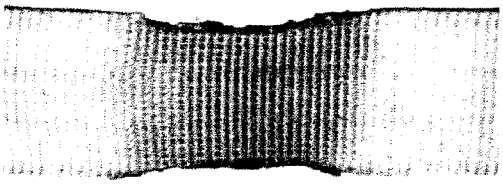
Inspection

As with all slings, synthetic web slings shall be visually inspected by the person using it each day of its use. These slings should be inspected for the following defects:

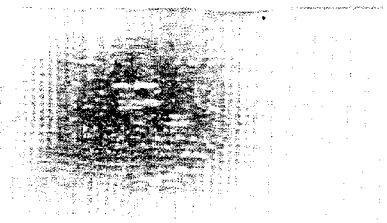
- ✓ Missing or illegible sling identification
  ASME B30.9-5.9.4(a)

- ✓ Acid or Caustic Burns
  ASME B30.9-5.9.4(b); CFR1910.184(i)(9)(i); CFR1926.251(e)(8)(i)

- ✓ Melting or Charring
  ASME B30.9-5.9.4(c); CFR1910.184(i)(9)(ii); CFR1926.251(e)(8)(ii)

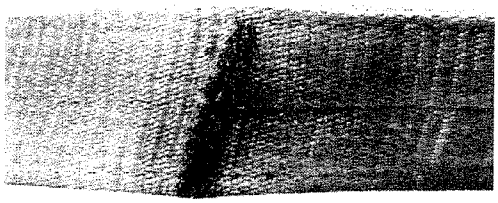


Acid Burn

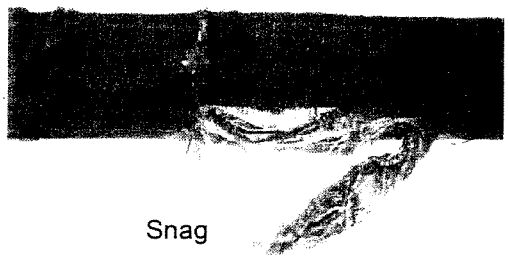


Melting

- ✓ Holes, Tears, Cuts or Snags
  ASME B30.9-5.9.4(d); CFR1910.184(i)(9)(iii); CFR1926.251(e)(8)(iii)



Cut

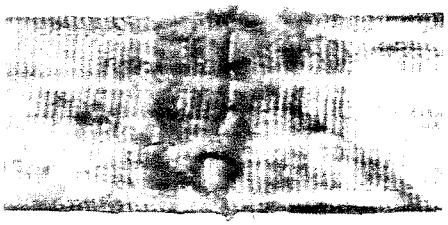


Snag

- ✓ Knots in any part of the sling
  ASME B30.9-5.9.4(g)

Knot

- ✓ Excessive abrasive wear
  ASME B30.9-5.9.4(f)



Abrasive Wear

✓ Broken or Worn Stitching in load bearing splices
ASME B30.9-5.9.4(e); CFR1910.184(i)(9)(iv); CFR1926.251(e)(8)(iv)

✓ Pitting, corrosion, cracks, distortion and broken end fittings
ASME B30.9-5.9.4(i); CFR1910.184(i)(9)(v); CFR1926.251(e)(8)(v)

✓ Discoloration and brittle or stiff areas on any part of the sling, which may mean chemical or ultraviolet/sunlight damage.
ASME B30.9-5.9.4(h); ASME B30.9-5.10.3(a)

✓ Any other conditions that might cause suspicion as to the slings integrity.
ASME B30.9-5.9.4(k)

Repairs

1) Synthetic web slings shall only be repaired by a sling manufacturer or equivalent entity.
ASME B30.9-5.9..53(a); CFR1910.184(i)(8)(i)

2) Repaired slings shall be marked to identify the repairing agency.
ASME B30.9-5.9..53(b)

3) Repaired slings shall be proof tested to twice the rated capacity before being returned to service.
ASME B30.9-5.9.5(f); CFR1910.184(i)(8)(ii)

   ✓ A certificate of the proof test shall be retained and made available for examination.
   CFR1910.184(i)(8)(ii)

4) Temporary repairs of either webbing, fittings, or stitching shall not be permitted.
ASME B30.9-5.9.5(i); CFR1910.184(i)(8)(iii)

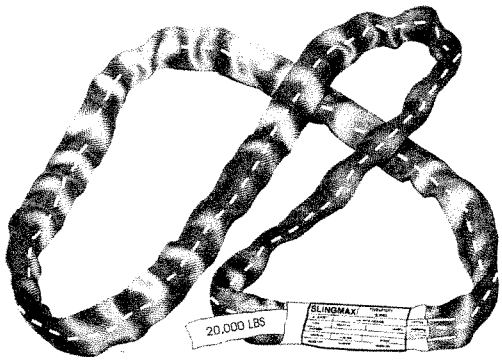
5) Cracked, broken, melted, or damaged webbing material or fittings other than hooks shall not be repaired.
ASME B30.9-5.9.5(d)

6) Modifications or alterations to the sling components shall be considered as repairs.
ASME B30.9-5.9.5(g)

7) There shall be no repairs to a load bearing splice.
ASME B30.9-5.9.5(h)

Synthetic Round Slings (Design Factor - 5:1 *ASME B30.9-6.2*)

Synthetic round slings are a single or Twin-Path® design usually made from strands of polyester fiber with a single or double protective covers. Load bearing strands may also consist of special high performance and/or heat resistant fibers. Be sure to follow the manufacturer's recommendations for use when using these special fibers.



Fittings

1) Fittings shall be compatible with the mechanical and environmental requirements imposed on the sling.
   ASME B30.9-6.8.3

2) Fittings shall be manufactured to ensure that the rated load shall be at least equal to that of the round sling.
   ASME B30.9-6.2.4(a)

3) Fittings shall have sufficient strength to sustain twice the rated load of the sling without permanent deformation and a minimum breaking strength equal to five times the rated capacity.
   ASME B30.9-6.2.4(b)

4) Surfaces shall be cleanly finished and sharp edges removed to prevent damage to the sling.
   ASME B30.9-6.2.4(c)

5) Previously used or welded fittings shall be proof tested to two times the vertical rated load of the sling.
   ASME B30.9-6.6.1

6) Follow the manufacturer's recommendations for the diameter and width of the bearing surfaces of fittings used with round slings
   ASME B30.9-6.3.1(e)

Identification *(ASME B30.9-6.7)*

1) Each round sling shall be marked, by the manufacturer, to show the following information:
   ASME B30.9-6.2
   - Manufacturer's identification;
     ASME B30.9-6.7.1(a)
   - Manufacturer's code or stock number;
     ASME B30.9-6.7.1(b)

- Rated loads for types of hitches & angles on which they are based;
  ASME B30.9-6.7.1(c)
- Core material;
  ASME B30.9-6.7.1(d)
- Cover material, if different from core material.
  ASME B30.9-6.7.1(e)

SLINGMAX®		TWIN-PATH® SLING
K-SPEC™	U.S. PAT. # 4,850,629	
TYPE	SERIAL NO.	LENGTH
TPXC2000		10 ft
RATED CAPACITIES IN LBS.		
VERTICAL	CHOKER	BASKET
20000 lbs.	16000 lbs.	40000 lbs.

5) Sling identification should be maintained by the user so as to be legible during the life of the sling.
   ASME B30.9-5.7.3

6) Replacement of the sling identification shall be considered a repair. Additional proof testing is not required.
   ASME B30.9-5.7.4

Proof test

When specified by the purchaser, round slings of all types shall be proof tested as follows:

1) The proof load for round slings shall be two times the vertical rated load.
   ASME B30.9-6.4(a)

2) The proof load for multiple leg round slings shall be applied to the individual legs and shall be two times the vertical rated load of a single leg.
   ASME B30.9-6.4(b)

3) *Multiple Leg Slings - the proof load shall be applied to the individual legs. Any master link to which legs are connected to shall be proof loaded to two times the force applied by the combined legs.

ASME B30.9-2.6.2(a)

Inspection *(ASME B30.9-6.4)*

As with all slings, round slings shall be visually inspected by the person using it each day of its use. These slings should be inspected for the following defects:

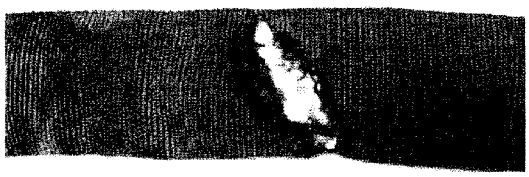
- ✓ Missing or illegible identification,
  ASME B30.9-6.9.4(a)
- ✓ Acid or caustic attack
  ASME B30.9-6.9.4(b)

Acid Attack

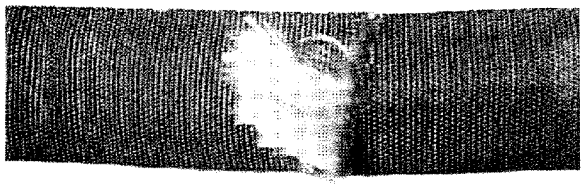
- ✓ Evidence of heat damage; *ASME B30.9-6.9.4(c)*

✓ Weld splatter that exposes core yarns
ASME B30.9-6.9.4(f)

✓ Hole, tears, cuts, abrasive wear or snags that expose core yarns of the round sling;
ASME B30.9-6.9.4(d)



Heat Damage



Damaged Core Yarn

✓ Broken or damaged core yarns;
ASME B30.9-6.9.4(e)

✓ Fittings when damaged, stretched, cracked, worn, pitted or distorted in anyway
ASME B30.9-6.9.4(i)

✓ Round slings that are tied into knots;
ASME B30.9-6.9.4(f)

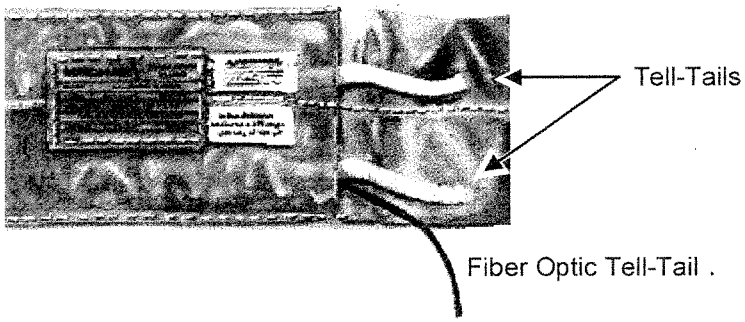
✓ Discoloration and brittle or stiff areas on any part of the sling, which may mean chemical or ultraviolet/sunlight damage.
ASME B30.9-6.9.4(h)

✓ Pitting, corrosion, cracks, bent, twisted, gouged, or broken end fittings
ASME B30.9-6.9.4(i)

✓ Other conditions including visible damage that cause doubt as to the continued use of the sling.
ASME B30.9-6.9.4(k)

✓ Some slings are equipped with optical tell-tails (a fiber optic) to assist in determining internal damage.

The condition of the internal core yarn can be inspected by checking the continuity of the fiber optic cable. If crushing, cutting, heat or chemical damage, has occurred then the damage to the fiber optic cable will destroy its ability to transmit light from one end to the other giving the inspector a reason to remove the sling from service and send it to the manufacturer for repair evaluation.



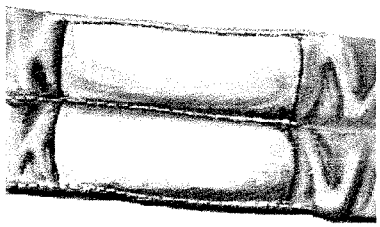
✓ Twin-Path® designs are equipped with Tell-Tail inspection to assist in determining internal damage

Tell-Tails should extend 1/2" past the tag area of each sling. If both Tell-Tails are not visible or they show evidence of chemical degradation remove the sling from service. Send to the manufacturer for repair evaluation.

Repairs *(ASME B30.9-6.9.5)*

1) Temporary repairs of either round slings or fittings shall not be permitted.
   ASME B30.9-6.9.5(i)

2) There shall be no repairs to load bearing yarns or fittings.
   ASME B30.9-6.9.5(h)



A Repair Patch

3) Round sling repairs shall be done by the manufacturer or a qualified person.
   ASME B30.9-6.9.5(a)

4) When repaired, a round sling shall be marked to identify the repair agent.
   ASME B30.9-6.9.5(a)

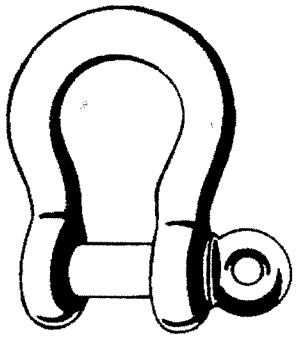
5) Cracked, broken, melted, or damaged webbing material or fittings other than hooks shall not be repaired.
   ASME B30.9-6.9.5(d)

6) Repaired round slings shall be proof tested to two times the vertical rated load before being put back into service.
   ASME B30.9-6.6.1(b)

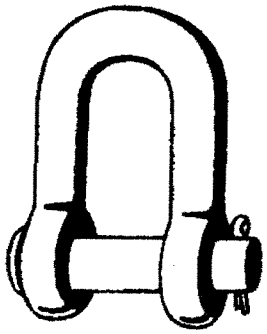
RIGGING HARDWARE

Shackles

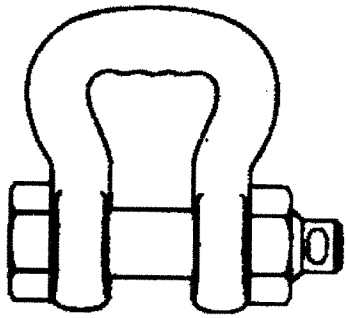
General Information



Anchor Shackle
Screw Pin Type



Chain Shackle
Round Pin Type

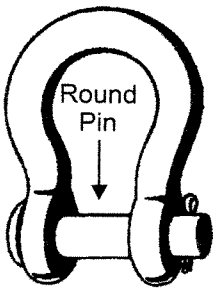


Synthetic Sling Saver Shackle
Safety Bolt Type

1) Shackles are manufactured in three basic configurations for rigging.

- Anchor shackles
- Chain shackle
- Synthetic shackles

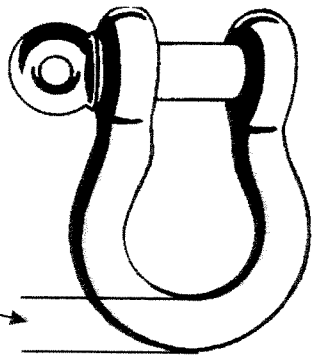
NOTE: Round pin shackles are not designed to be used in a general rigging atmosphere.



2) Shackle design factors depend on their size.

- Shackles up to 4 inches a factor of 5 is required.
- Shackles larger than 4 a factor of 4 is required.

3) In most cases, shackle size is determined by the diameter of the steel in the body (bow) of the shackle.

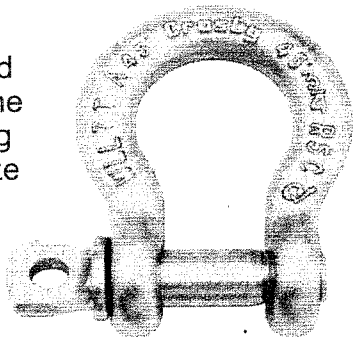


Anchor and Chain shackle size is determined by the bow diameter

Identification

1) Shackles which are not properly marked by the manufacturer shall be discarded.

2) Each shackle body shall be permanently and legibly marked in raised or stamped letters on the side of the shackle body with an identifying manufacturer's name or trademark, shackle size and its Working Load Limit *(WLL)*.



- Shackle pins and bolts shall be unmarked.

Inspection

Before each use, shackles shall be inspected to the following criteria:

1) Shackle pins shall fit freely without binding.

   ✓ Seated screw pin shackles shall be able to be disassembled by hand after the first half turn.

   ✓ The pin shall show no sign of deformation.

   ✓ Shackles shall not be used if the pin cannot be completely seated.

2) Shackles shall have no defect that will interfere with serviceability.

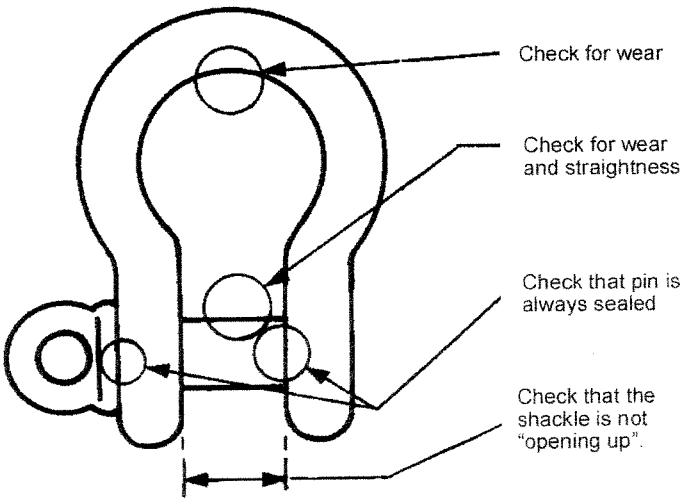
   ✓ Shackle opening up more than its original distance

   ✓ Damaged threads

   ✓ Illegible or improper markings

   ✓ Wear greater than 10% of normal diameter *(pin or body)*

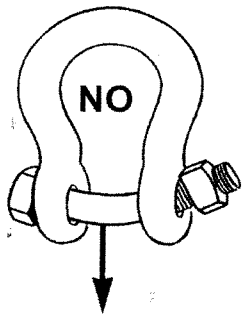
   ✓ Cracks or other deformations

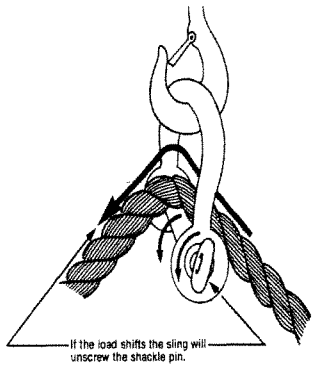


Operating Guidelines

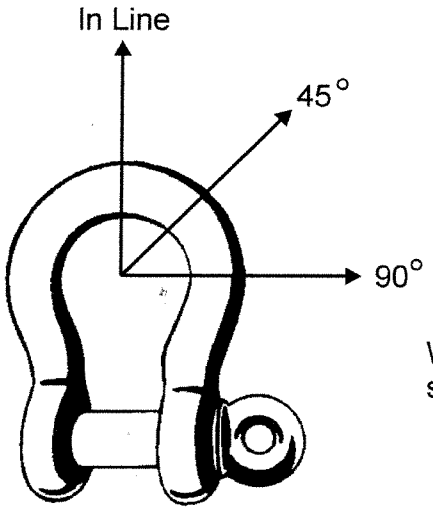
1) Never replace the shackle pin with a bolt, only a properly fitted pin shall be used. Bolts are not intended to take the loading that is normally applied to the pin.

2) Screw pin shackles shall not be used if the pin can roll under loading and become unscrewed.





3) Ratings on shackles are for in-line loading. *(The bolt or pin is perpendicular to the load)*. Shackle capacity shall be reduced accordingly when pulled at an angle to the pin.



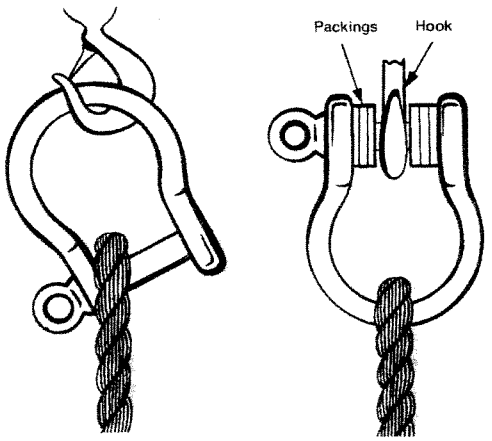
(The Crosby Group - page 65)

- 45 degree a reduction of 30% capacity
- 90 degree a reduction of 50% capacity

WARNING: Round pin shackles shall never be side loaded.

4) The shackled pin should go in the hook whenever more than one sling or other lifting device is attached to the shackle.

- Washers may be used to pack the pin to centralize the shackle if necessary.



G-Link™ Connectors (Design Factor 5:1)

G-Links™ are used to connect synthetic web and round slings to each other and to hardware.

1) Made from forged or alloy steel.
2) Size is determined by the capacity and sling width
3) Capacity is to be stamped or embossed on link.
4) Capacities are doubled when links are doubled up.
5) When connecting slings to hardware

Inspection

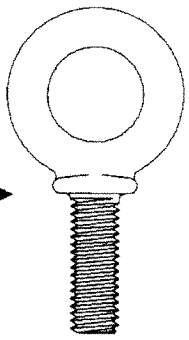
When damage such as the following is visible remove G-Link™ connectors from service.

- ✓ Be sure both sides are equal in length
- ✓ Check for twisting and opening up of the link.
- ✓ Cracks in any part of the link

Eye Bolts

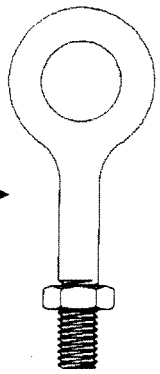
General Requirements

1) Only shouldered eye bolts shall be used, when loading is NOT vertical *(90 degrees from horizontal)*.



Shouldered Eye Bolt

- When non-shouldered eye bolts are used, they must be used only in vertical pulls.

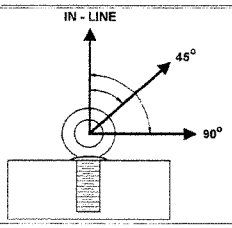


Non-Shouldered Eye Bolt

2) The WLL rating shall have a minimum design factor of 5. When loading at an angle the WLL must be modified to ensure compliance with the minimum design factor of 5.

EYE BOLTS

* Shoulder Type Only
* Forged Carbon Steel



Stock Diameter (inches)	Working Load Limits (lbs) Corresponding to Angle of Pull		
	In-Line Pull	45°	90°
1/4	650	195	162
5/16	1,200	360	300
3/8	1,550	465	387
½	2,600	780	650
5/8	5,200	1,560	1,300
3/4	7,200	2,160	1,800
7/8	10,600	3,180	2,650
1	13,300	3,990	3,400
1-1/4	21,000	6,300	5,250
1-1/2	24,000	7,200	6,000

The Crosby Group (pg 140)

3) Nuts, washers, or drilled plates shall not be used or assembled to make shouldered eye bolts.

4) Shoulders shall seat uniformly and snugly against the surface on which they bear.

Identification

Each eye bolt shall have the manufacturer's name or identification mark forged in raised characters on the surface of the eye bolt.

Inspection

✓ Careful visual inspection of each eye bolt immediately before use is mandatory. Eye bolts that are cracked, bent or have damaged threads should be discarded.

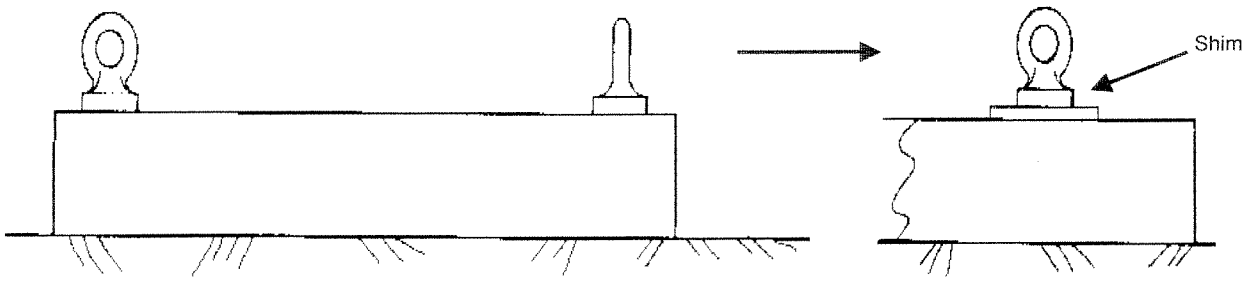
✓ The shank of the eye bolt shall not be undercut and shall have a smooth radius into the plane of the shoulder.

Operation Practices

1) The size of the hole shall be checked for the proper size of eye bolt prior to installation. The conditions of the threads in the hole shall be checked to ensure the eye bolt will secure and the shoulder can be brought to a snug and uniformly engaged seat.

2) The shoulder of the eye bolt must be flush with the surface.

   • When eye bolts cannot be properly inserted and aligned with each other, properly sized washers or shims may be inserted under the shoulder to facilitate the tightening and aligning of the eye bolts.



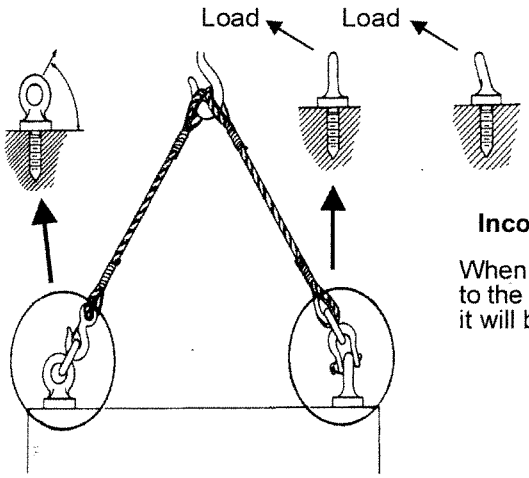
When eye bolts can not be aligned...

...Use a shim

3) To keep bending forces on the eye bolt to a minimum, the load shall always be applied in the plane of the eye, never in the other direction.

Correct Orientation

Load is in the plane of the eye.

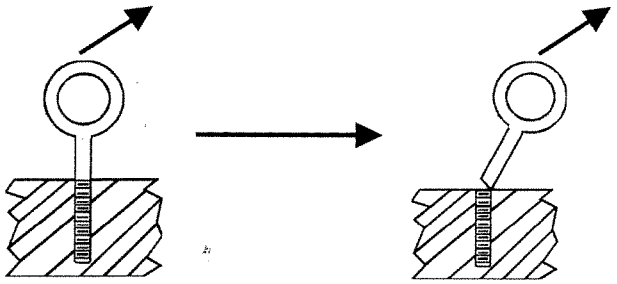


Incorrect Orientation

When the load is applied to the eye in this direction it will bend.

4) Angular loading of the eye bolts should be avoided. Angular loading occurs in any lift in which the lifting force is applied at an angle to the centerline of the shank of the eye bolt.

- Never angular load non-shouldered eye bolts.



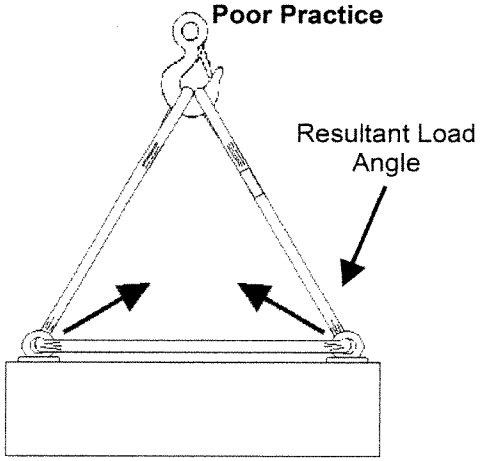
Results of angular loading non-shouldered eye bolts.

5) When more than one eye bolt is used in conjunction with multiple-leg rigging, it is recommended that spreader bars, lifting yokes or lifting beams be utilized to eliminate angular loading.

6) If a rigging hook will not go completely into the eye bolt, a shackle shall be used to avoid hook tip loading.

7) Slings should not be reeved through a pair of eye bolts. Only one leg should be attached to each eye bolt. Reeving sling through eye bolts adds greater load tension in the eye bolt than normally calculated by using the sling angle.

Poor Practice



Swivel Hoist Rings

General Information

1) Determine the loads on each hoist ring and select a ring whose Working Load Limit (WLL) will not be exceeded.

2) Install hoist ring to recommended torque value *(imprinted on top of the swivel)* with a torque wrench. Be sure the bushing flange meets the load surface.

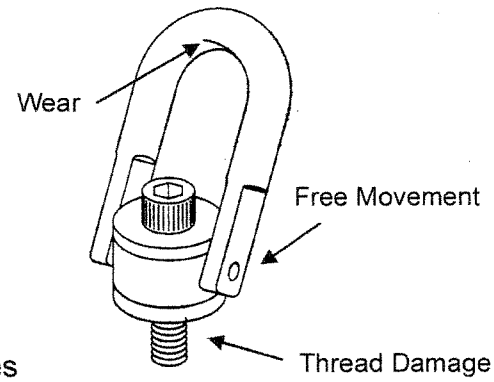
3) Never use spacers between bushing flange and mounting surface.

4) After placement check hoist ring for proper rotation and alignment. There should be no interference between load and hoist ring bail.

5) When installed with a retention nut, the nut must have full thread engagement and must meet one of the following standards to develop the WLL.

   - ASTM A-563 *(A)* Grade D Hex Thick *(B)* Grade DH Standard Hex
   - SAE Grade 8 - Standard Hex

Inspection



Always inspect hoist ring before use for:

✓ Signs of corrosion, wear or damage,

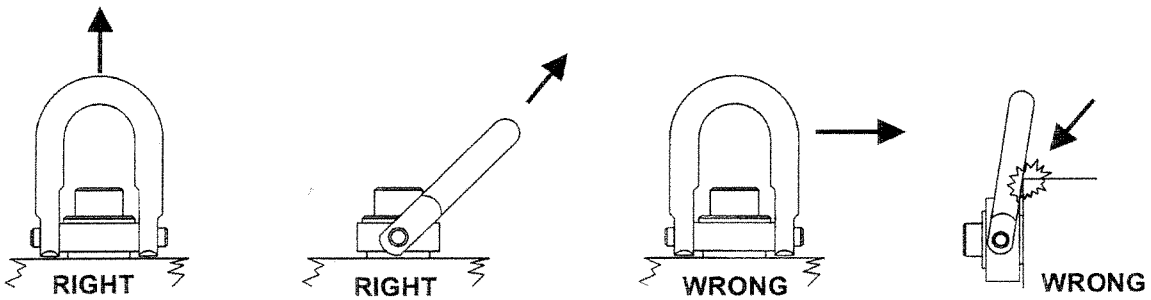
✓ Bail for bending and elongation,

✓ Be sure threads on shank and receiving holes are clean, not damaged and fit properly,

✓ Check torque with torque wrench before using already installed rings,

✓ Make sure there are no spacers used between bushing flange and the mounting surface,

✓ Always ensure free movement of bail. It should pivot 180° and swivel 360°



Rigging Hooks

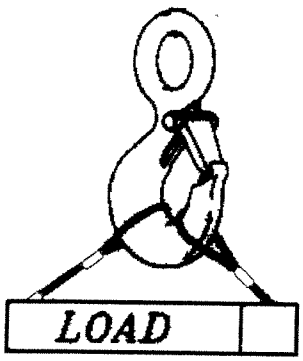
General Information

1) Rigging hooks are hooks that do not necessarily support a load in a direct-pull configuration, such as grab hooks, sorting hooks and sling hooks.

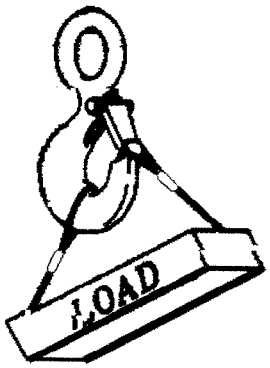
2) The WLL for a rigging hook shall be equal to or exceed the rated load of the chain, wire rope or other suspension member to which it is attached.

   - The designed WLL applies only when the load is applied in the saddle of the hook.

RIGHT



WRONG



3) The manufacturer's identification shall be forged or die-stamped on a low stress and non-wearing area of the hook.

Inspection

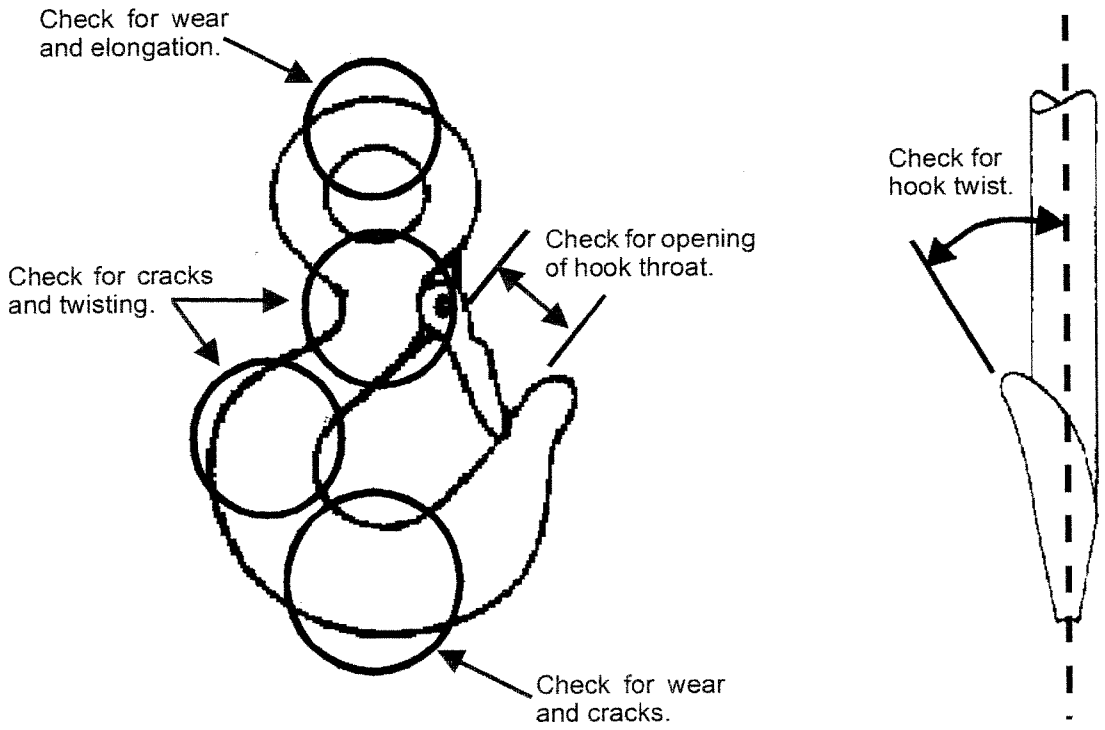
✓ Look for distortions such as bending and twisting exceeding 10 degrees of the point from the plane of the center axis of the hook.

✓ Check for increase in throat opening exceeding 15% of original throat opening.

NOTE: It is strongly recommended to remove hooks from service if any evidence of deformation of any sort is present.

- ✓ Check for wear in the saddle and eyelet area of the hook. Wear exceeding 10% of the original dimension is sufficient enough to take the hook out of service.
- ✓ Check for cracks, severe nicks and gouges.
- ✓ Check the hook attachment and securing means for defects.
  - Rigging hook shall be inspected as part of the sling to which they are attached.

RIGGING HOOK INSPECTION POINTS



Turnbuckles

Types of Turnbuckles

Jaw & Jaw

Jaw & Eye

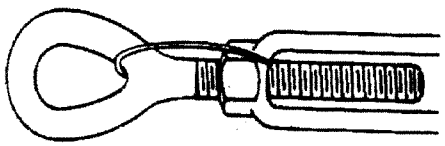
Hook & Eye

Hook & Hook

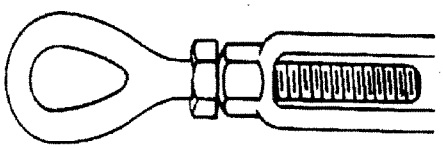
General Information

1) Turnbuckles used in hoisting and rigging operations shall be fabricated from forged alloy steel.

2) If a turnbuckle is used in an application where vibration is present, the end fitting should be secured to the frame with lock pins or wires to prevent them from turning and loosening.



GOOD PRACTICE



POOR PRACTICE

- Lock nuts *(jam nuts)* should not be used during overhead lifting. They can significantly increase the stresses imposed upon the turnbuckle's threads.

3) Hook end turnbuckles have reduced capacities compared to the other types.

TURNBUCKLES

- Weldless Construction
- Forged Alloy Steel

End Fitting Stock Diameter (inches)	WLL of any combination of JAW, EYE and STUB END Fittings (lbs)	WLL of Turnbuckles with HOOK END Fittings (lbs)
1/4	500	400
5/16	800	700
3/8	1,200	1,000
½	2,200	1,500
5/8	3,500	2,250
3/4	5,200	3,000
7/8	7,200	4,000
1	10,000	5,000
1 -1/4	15,200	6,500
1-1/2	21,400	7,500
1-3/4	28,000	--------
2	37,000	--------
2-1/2	60,000	--------
2-3/4	75,000	--------

Inspection

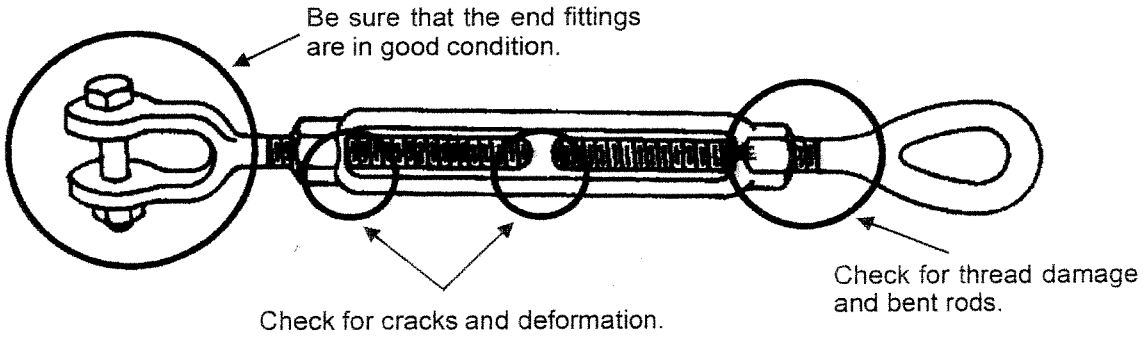
Turnbuckles shall be inspected for the following before each use.

✓ Cracks and bends in the frame.

✓ Thread damage and bent rods.

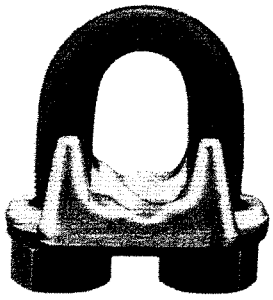
- Damaged threads and bent frame members shall disqualify the unit for use.

✓ Check for deformed, bent or cracked end fittings.

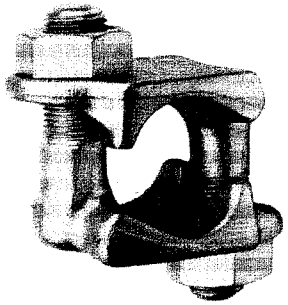


Wire Rope Clips

Clips shall be legibly and permanently marked with size and the manufacturer's identifying mark.



U-Bolt Clip



Fist Grip® Clip

Inspection

Before use, wire rope clips shall be visually inspected for:

✓ Damage, corrosion, wear and cracks.

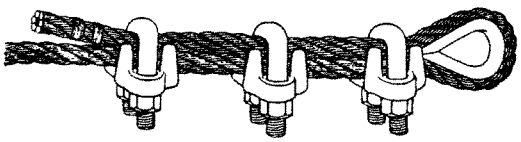
✓ Verify that the components are properly marked

✓ Ensure that the assembled clip contains the same size, type and class parts.

Operation Practices

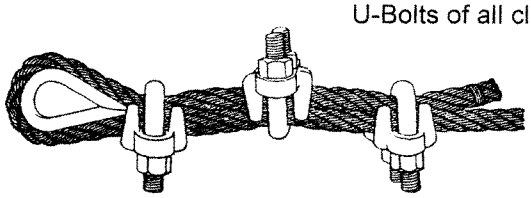
1) Ensure clips are orientated correctly

2) When using U-bolt (single grip) clips, be sure to put the saddle on the live end of the wire rope.



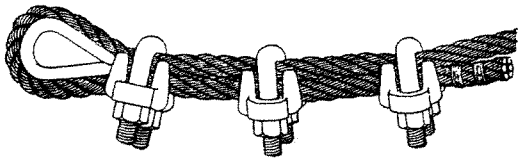
Correct

U-Bolts of all clips are on dead end of wire rope.



Incorrect

Do not stagger wire rope clips.



Incorrect

U-Bolts of all clips are on live end of wire rope.

3) Be sure to torque clips to proper specifications.

4) Check torque after use and retorque after use when necessary.

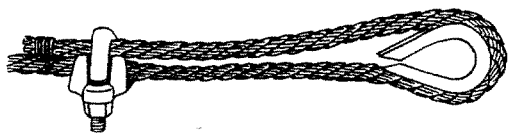
5) Follow the proper procedure when installing clips

- Apply first clip one base width from dead end of wire rope. Tighten nuts evenly to recommended torque.
- Apply second clip nearest the loop. Turn nuts evenly, but DO NOT TIGHTEN.
- Apply all other clips spaced equally in between the first two. Apply tension and tighten all nuts to recommended torque.
- Retorque after use.

Note: Be sure to follow manufacturer's recommendations for number of clips, torque and installation.

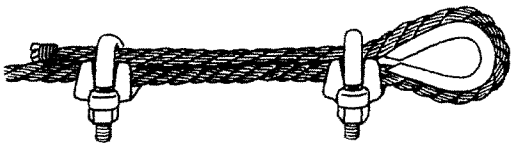
Installation of Wire Rope Clips

STEP 1



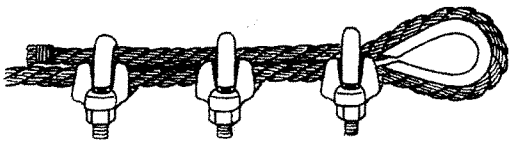
APPLY FIRST CLIP - one base width from dead end of wire rope. Tighten nuts evenly to recommended torque. U-Bolt over dead end of wire rope.

STEP 2



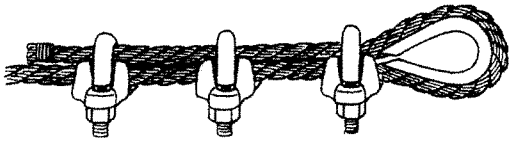
APPLY SECOND CLIP - nearest the loop. Turn nuts evenly, but DO NOT tighten. U-Bolt over dead end.

STEP 3



APPLY ALL OTHER CLIPS - spaced equally in between the first two. Apply tension and tighten all nuts to recommended torque. U-Bolt over dead end.

STEP 4

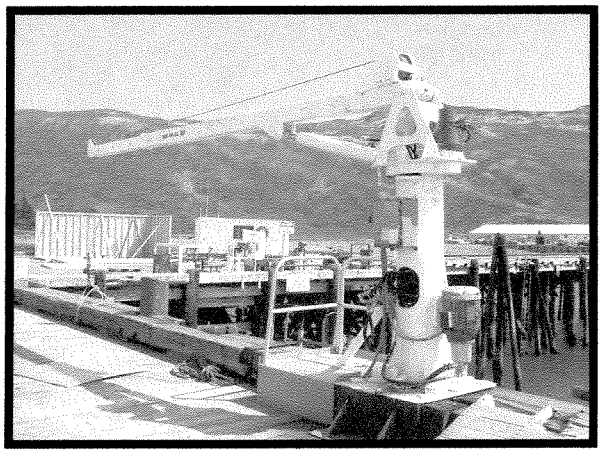


Retorque after use.

Student Manual

Dock & Vessel Mounted

Pedestal Crane Operator Safety Training



CH CRANE & RIGGING CONSULTANTS, INC.
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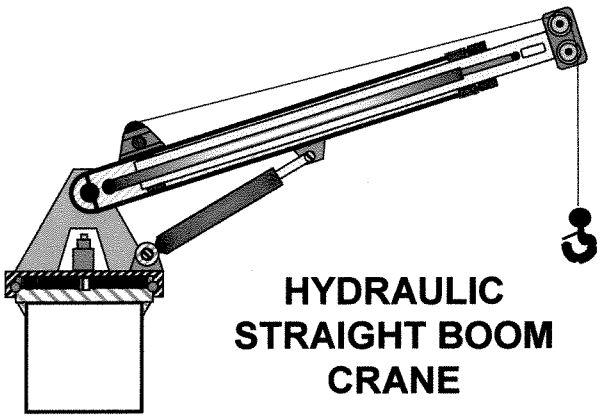
Joe Cowen 979-203-3045 • Derek Henson 979-224-5029

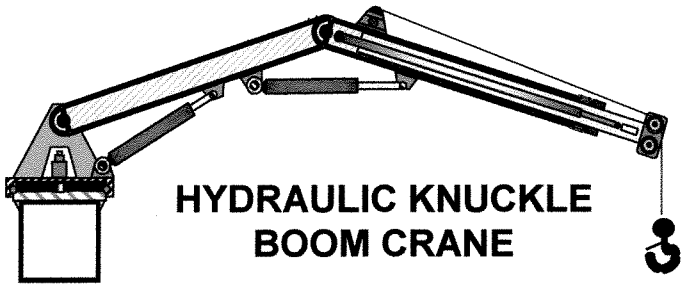
TYPES OF DOCK MOUNTED PEDESTAL CRANES

There are basically two types of hydraulic pedestal cranes used on docks.



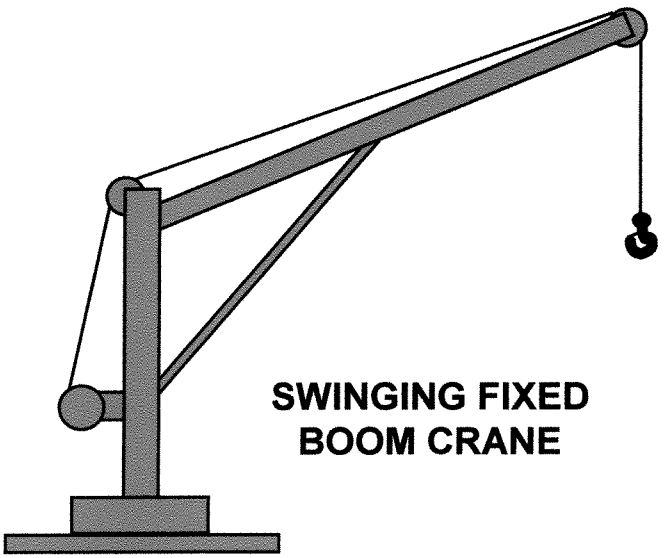
HYDRAULIC STRAIGHT BOOM CRANE

The first is the telescopic straight boom crane. Other than the normal features of a crane, the boom can be extended in and out. This feature allows the crane to reach out further and higher when the need arises.



HYDRAULIC KNUCKLE BOOM CRANE

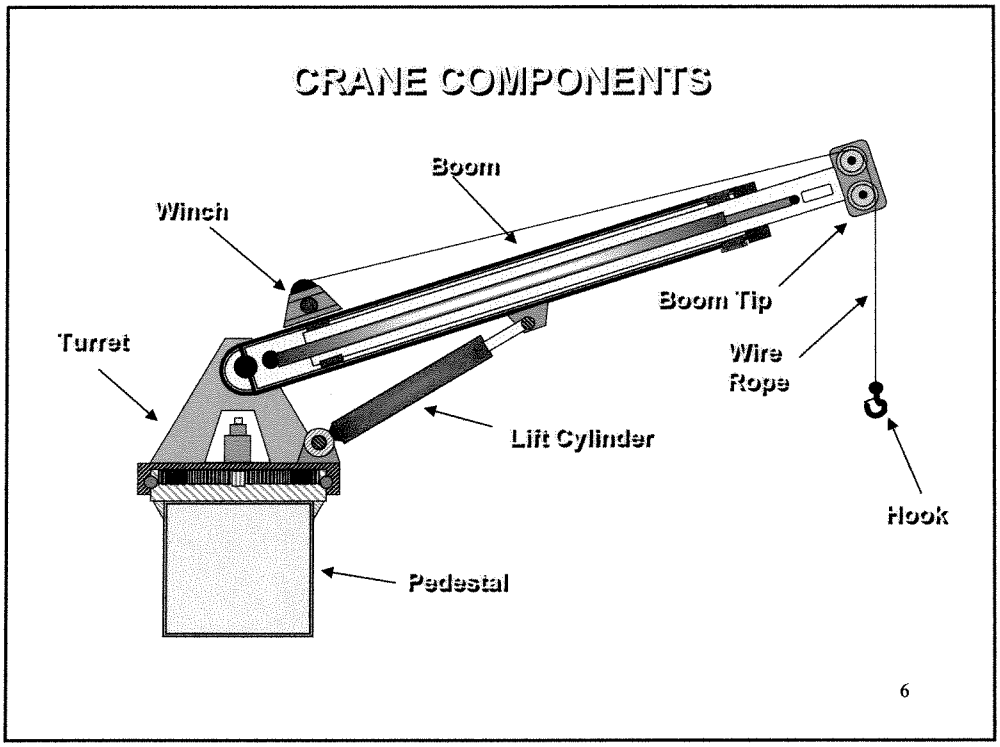
The second type of crane is the knuckle boom crane. This crane has two boom sections. The second boom section hinges at the tip of the first section. Each boom section can be operated independently of the other and this feature allows the operator to position the load more accurately. The second boom section may also be fitted with a telescopic section.

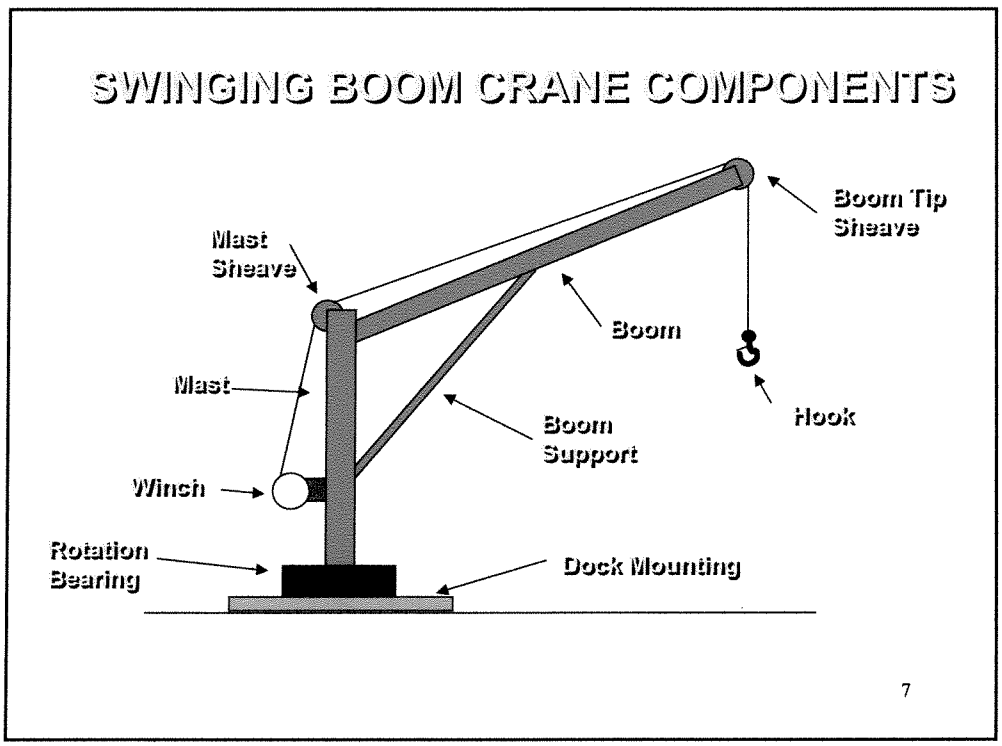


SWINGING FIXED BOOM CRANE

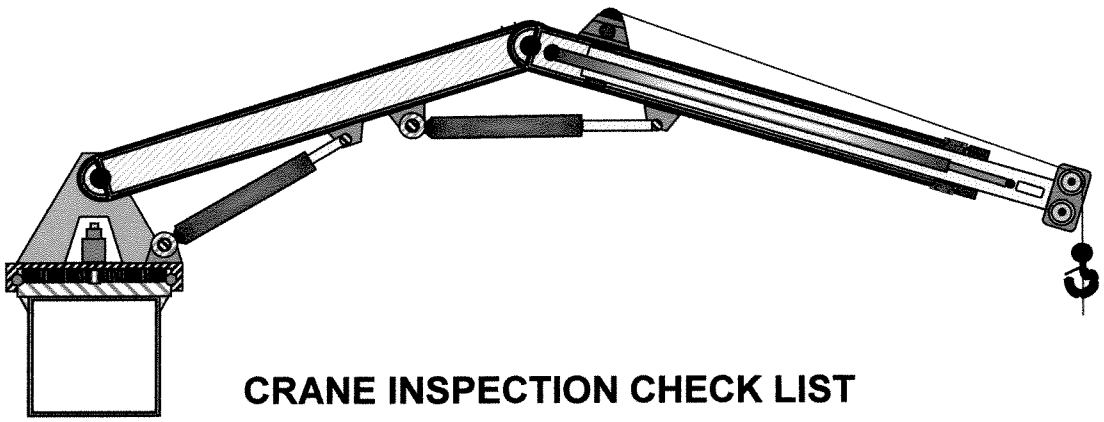
The swinging boom type of crane is the simplest crane found on most docks. It consists of a fixed length boom that is mounted on a vertical mast. The boom cannot be raised or lowered. Crane rotation is typically manual, by means of bar or pipe which is pushed or pulled to rotate the crane. The winch used to hoist the load is often electrically powered, with the up / down control mounted on the end of an electrical cord

CRANE COMPONENTS





CRANE INSPECTION

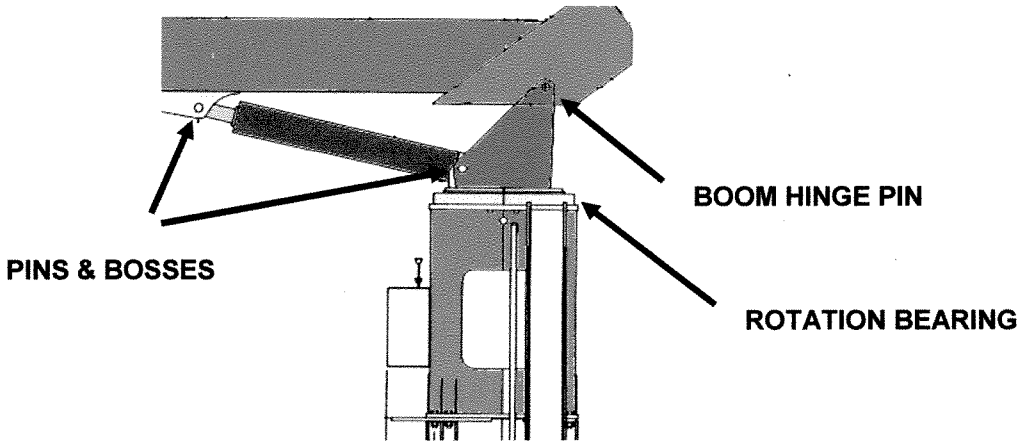


CRANE INSPECTION CHECK LIST

INSPECTION AREA	INSPECTION RESULTS			
	Sat.	Unsat.	N/A	Comments
Supporting Structure				
Welds				
Bolts				
Rotating System				
Bull & PinionGear				
Swing Brakes				
Hydraulic Drive Motor				
Boom				
Welds				
Stress & Distortion				
Hinge Pin				
Boom Cylinder & Pins				
Wear Pads				
Telescopic Operation				
Tip Section & Sheaves				
Angle/Radius Indicator				
Anti-Two Blocking Sys.				
Winch System				
Wire Rope Condition				
Rope Reeving				
Mounting Bolts				
Brakes				
Functional Operation				
Hydraulic System				
Pump Performance				
Control Functions				
Control Markings				
Hydraulic Leaks				
Hose Condition				
Fluid Level				
Load Block				
Sheaves				
Pins				
Swivel				
Hook				

The operator is responsible for inspecting the crane prior to using it.

TURRET INSPECTION

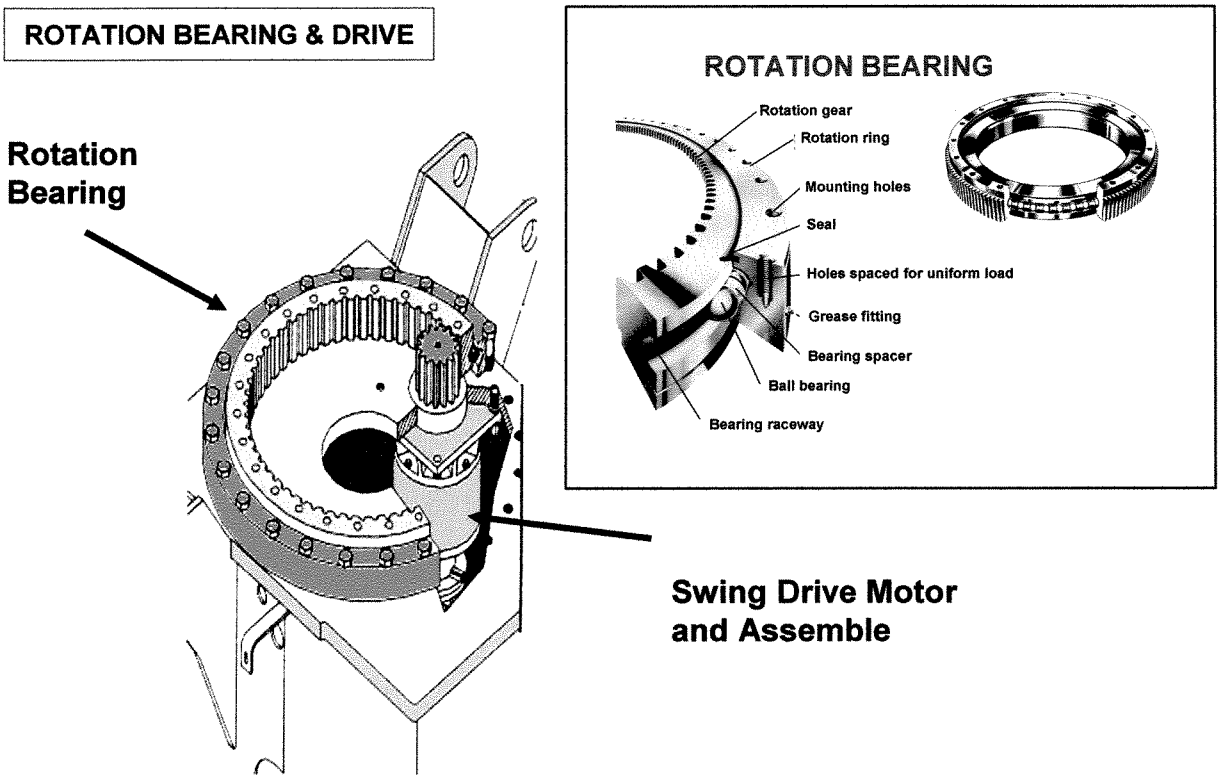


The four areas in the slide can be checked by performing the following test:

- Retract the boom fully and raise it to its most vertical position and extend the hoist wire about 10 feet.
- Abruptly lower the boom momentarily which will result in the turret and boom component rocking. Observe the movements in the rotation bearing, boom hinge pin and bushing, and the lift cylinder pins and bushings. CAUTION: WHEN SHAKING THE CRANE, OBSERVE THE HOOK AND STOP ANY BOOM MOVEMENT IF IT CAN SWING INTO THE BOOM.
- Any excessive movement must be noted and evaluated per the manufacturer's specifications.
- Check the turret area for cracked welds and any deformed components.

ROTATION INSPECTION

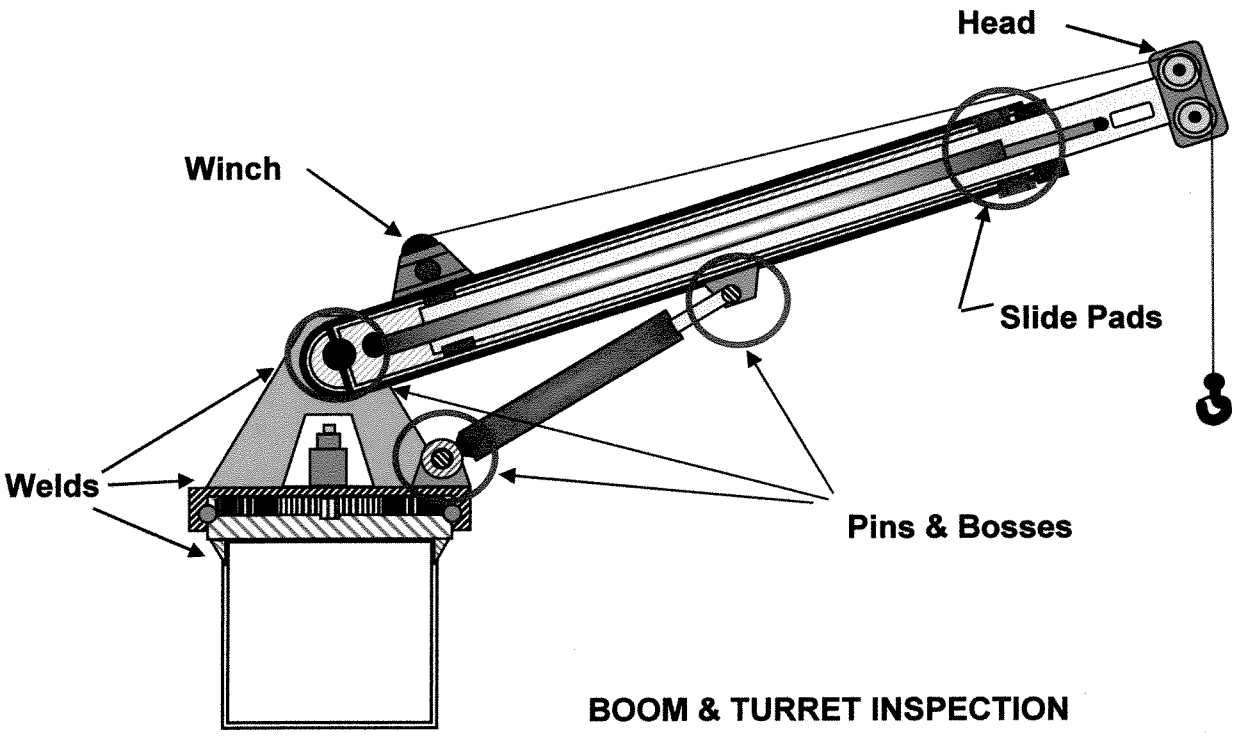
ROTATION BEARING & DRIVE



The only thing that keeps the boom from detaching from the pedestal is the rotation bearing. If it fails, the boom comes down.

- The rotation bearing should be greased on a regular basis per the manufacturer maintenance manual.
- The rotation bearing is attached to the pedestal by bolts. These need to be checked for tightness. The turret is also attached to the bearing with bolts and they also need to be checked.
- The rotation drive motor is typically mounted up in the pedestal and the mounting bolts need to be checked.
- Check the ring and pinion gears for grease.

CRANE INSPECTION

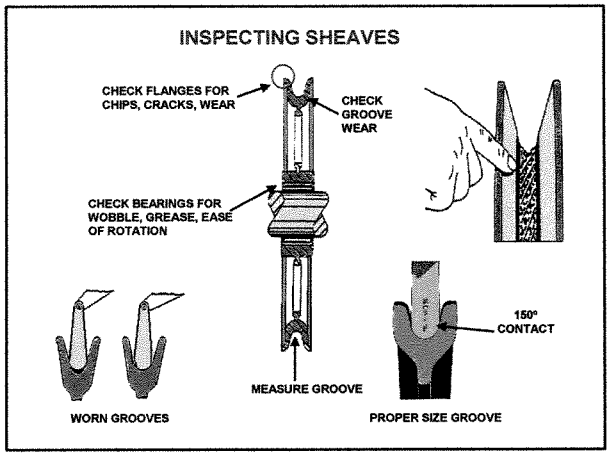


BOOM & TURRET INSPECTION

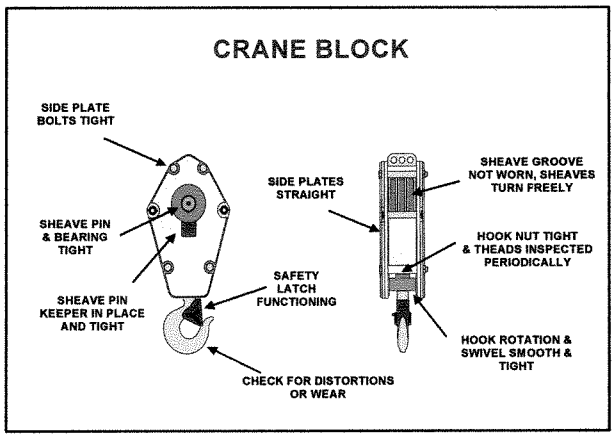
- The boom needs to be extended and checked for smoothness of operation. Any binding or difficulty in extending could be the result of damaged boom sections.
- All welds need to be checked for cracks.
- Any hydraulic leaks need to be investigated and repaired. Check the hoses for chaffing and wear.
- The slide pads can be checked for proper alignment by extending the boom completely and lowering the tip toward the ground. Move the boom tip back and forth by pushing on it and observe how much the boom sections move inside each other. Excessive movement will require the slide pads to be adjusted or replaced.
- The boom tip needs to be checked for deformation and twisting.
- The winch should be checked for proper reeving. The most common cause of damage to wire rope is crushing due to crossed wraps on the winch drum.

CRANE INSPECTION

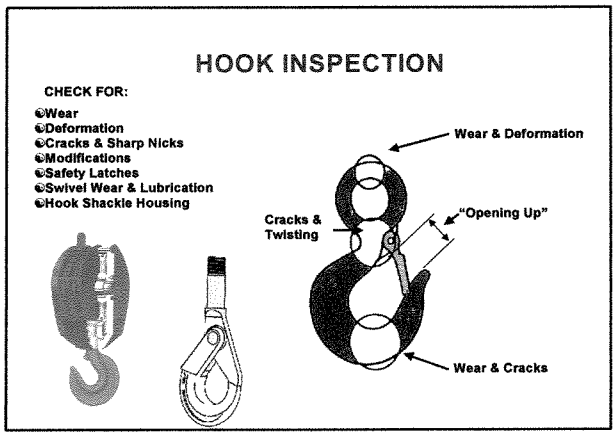
- Check sheaves for bearing wear and lubrication.
- Check the flanges and treads. Use a sheave gauge.
- Sheaves can only be repaired per manufacturer's procedures.



- The sheaves and bearings need to be checked on crane blocks.
- Check the side plates and any additional weights attached to the sides need to be checked for loose or missing bolts or fasteners.
- The hook and shank nut should be separated periodically and the threads inspected for corrosion and other damage.
- The safety latch must be in place and functioning properly.
- The hook should rotate freely on the swivel bearing. Check for excessive movement.



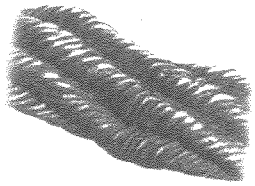
- Wear in excess of 5% in the neck of the hook and 10% in other areas is cause for removal.
- An increase in the hook throat opening of more than 15% is cause for removal
- Any twist in the hook of more than 10% is cause for removal.
- Hooks can only be repaired per manufacturer's procedures.



WIRE ROPE INSPECTION

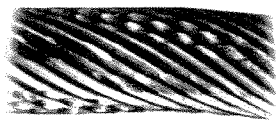
Kinks are a permanent distortion. After a wire rope is kinked it is impossible to straighten the rope enough to return it to its original strength. The rope must be replaced. Causes: crossed lines on drum, improper handling and installation, and uncoiling.

KINKED WIRE ROPE



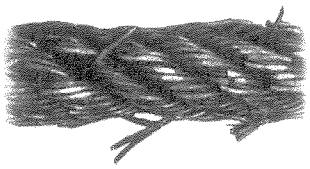
Strand Nicking is due to continued operation under a high load which results in core failure.

STRAND NICKING



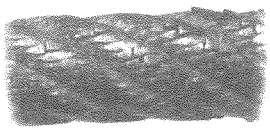
Metal Fatigue is usually caused by bending stress from repeated passes over sheaves, or from vibration such as crane pendants.

FATIGUE FAILURE



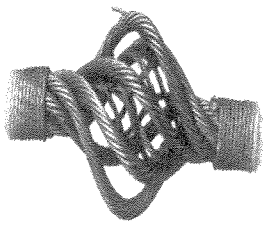
Fatigue Breaks can be either external or internal. They also can be caused by wobbly sheaves, tight grooves, poor end terminations. In the absence of all these causes, remember that all wire rope will eventually fail from fatigue.

FATIGUE BREAKS



Bird Caging is a result of mistreatment such as sudden stops, wound on too tight of drum, or pulling through tight sheaves. The strands will not return to their original position

BIRDCAGE



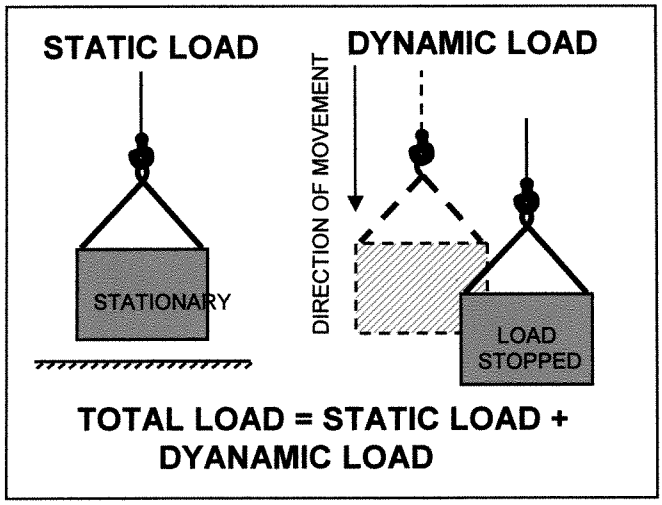
High Stranding is a condition caused when overloading and crushing take place and the other strands become overloaded.

HIGH STRAND

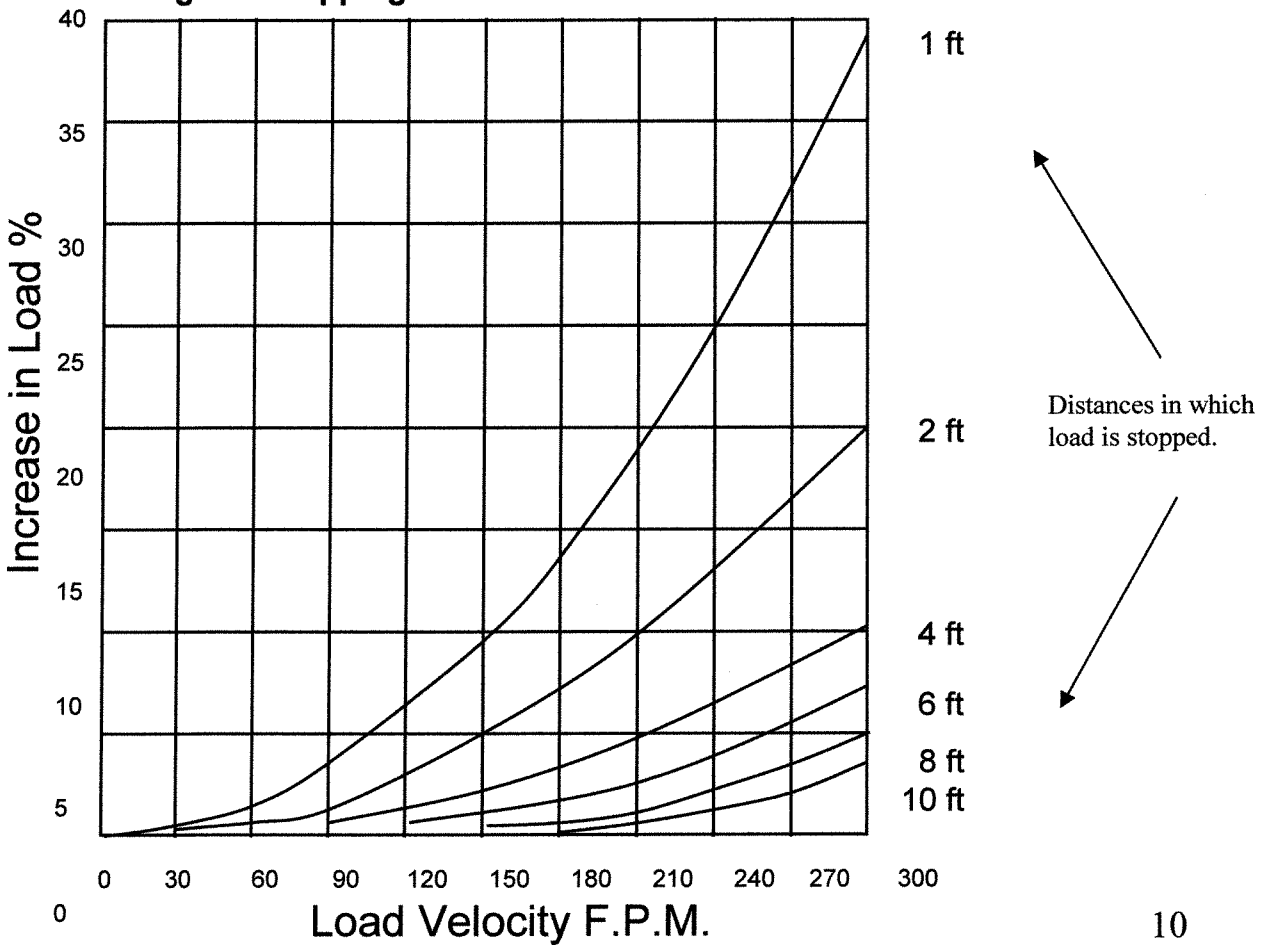
DYNAMIC LOADING

IMPACT OF DYNAMIC LOADING

When a load is moved, additional stresses are imposed on the crane's structure. To start a load moving either by hoisting, booming or swinging, the crane will have to exert an additional force. How much additional force is dependent on the weight of the load and how fast it has started moving. Loads started slowly and stopped slowly will not exert as much stress on the crane as those which are move rapidly.

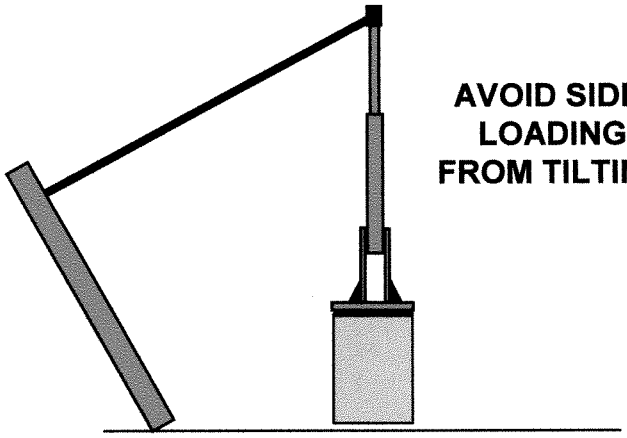


The below chart shows how the dynamic load increases as the rate of starting and stopping the load increases.

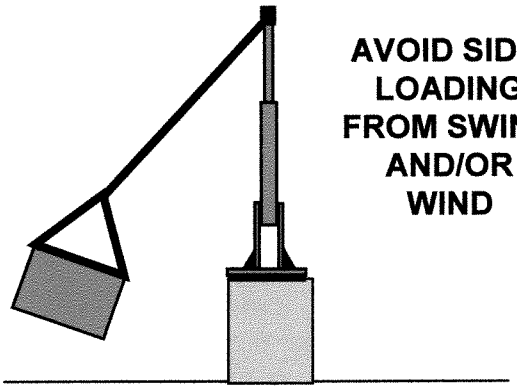


SIDE LOADING

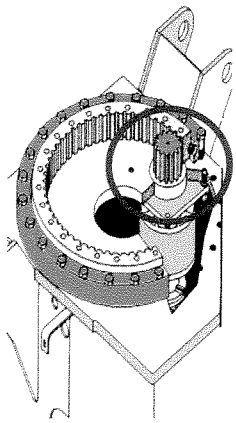
The boom is very susceptible to side loading damage and needs to be above the load at all times. Tilting up panels are a common cause of side loading. When tilting up a panel, the hoist line must remain vertical at all times. Although it is not very apparent, wind can cause excessive stresses on the crane. The operator must stop operations when the wind becomes a significant factor. The wind pressure on the load can also add side loading to the boom as well as losing control of the load. Tag lines may be necessary to help control the load, but should never be used to pull the load around.

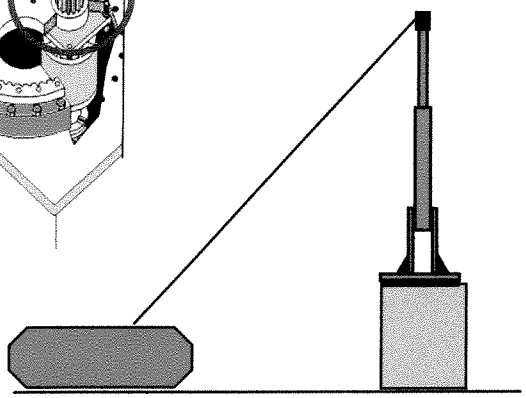


AVOID SIDE LOADING FROM TILTING



AVOID SIDE LOADING FROM SWING AND/OR WIND



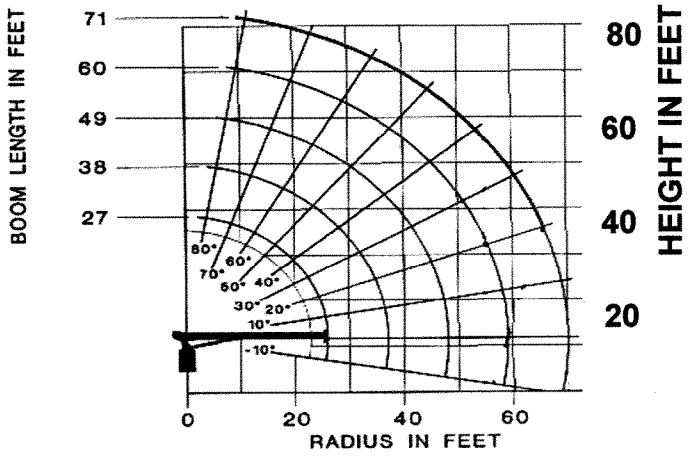


Never intentionally side load the crane by yarding or dragging a load on the ground. This could seriously damage the boom or swing mechanisms on the crane. Knuckle booms are particularly suseptable to damage from this practice. This puts tremendous strain on the pinion gear of the swing motor which over time could fail.

LOAD CHART

The range diagram shows the various boom tip heights based on boom length and radius. This chart will help to determine if this crane is able to make a certain lift.

RANGE DIAGRAM



RATED LOAD CAPACITY CHART

BOOM RETRACTED			BOOM EXTENDED		
BOOM ANGLE IN DEG.	LOAD DIST. IN FEET	LOAD CAP. IN POUNDS	BOOM ANGLE IN DEG.	LOAD DIST. IN FEET	LOAD CAP. IN POUNDS
63	10	24,000	79	10	16,000
47	15	17,170	73	15	12,800
30	20	13,140	68	20	9,700
1	22	10,700	58	25	8,250
			50	30	6,960
			45	35	5,900
			38	40	5,130
			27	45	4,500
			1	50	3,300

The load capacity section of the load chart states the lifting capacity of the pedestal crane for a given radius and boom length. A typical chart will show the radius in the left hand column and the corresponding boom angle and length on top. If the desired radius falls between two figures on the chart, the longer of the two must be used with their corresponding angles and capacities. Never try to "split the difference." The boom angles on the chart are for **loaded** booms. When pre-determining where the boom angle is to be used as a means for establishing the radius, 2 degrees should be added to the load chart number. As the boom is loaded, it will tend to drop a few degrees, so the 2 degrees should compensate for that.

CRANE SAFETY

- Do not leave the crane with a suspended load
- Rig the crane with sufficient parts of line for the load
- Avoid two-blocking the crane
- Always have a minimum of three wraps of cable on the drum
- Monitor the winch to make sure that it is spooling correcting
- Do not lift loads over personnel
- Lift one load at a time

MAKING THE LIFT

Review the lift scenario with the operator, riggers and signal person

Attach taglines when necessary

Position signal person within visibility of the load and operator

Begin by lifting the load *slowly*

Re-check the boom angle indicator to assess radius increase

Keep load as low as possible when moving it

Swing *slowly* to avoid swing out.

Avoid erratic booming

Follow signal and stop operation when uncertain

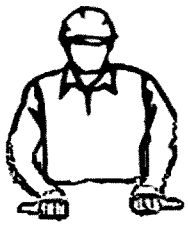
Lower load *slowly*

SIGNALS

- Only one person should be designated as the signal person.
- The emergency stop signal can be given by anyone on the site.
- The signals must be clear and precise.
- The crane operator should never respond to a signal that is not clearly understood.

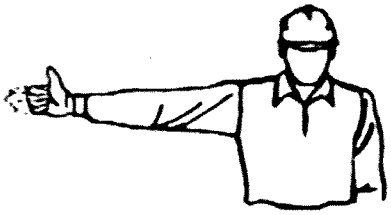
HAND SIGNALS

DOG EVERYTHING

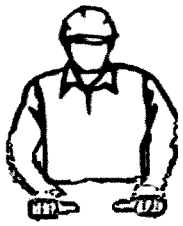


EXTEND BOOM

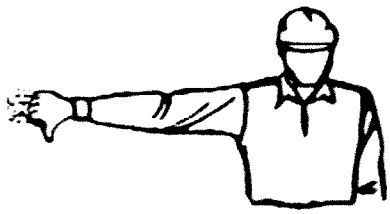
EMERGENCY STOP



LOWER THE LOAD
RAISE THE BOOM

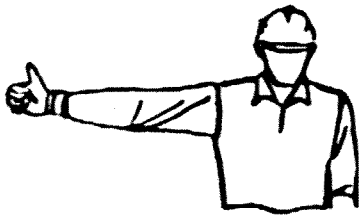


RETRACT BOOM

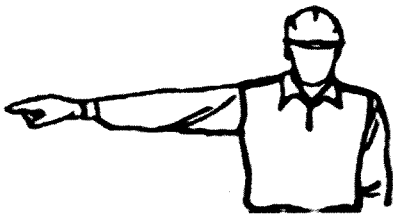


RAISE THE LOAD
LOWER THE BOOM

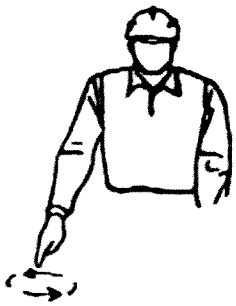
RAISE THE LOAD



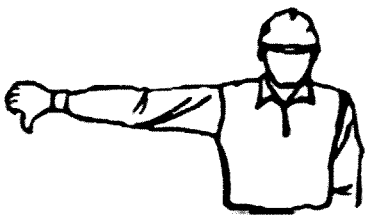
RAISE THE BOOM



SWING



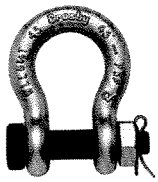
LOWER THE
LOAD



LOWER THE BOOM

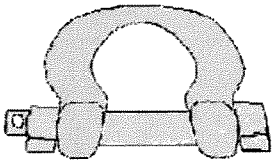
STOP

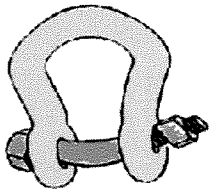
SHACKLE INSPECTION

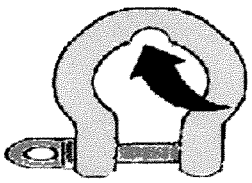


The working load limit (WLL) must be printed on the shackle or it must be taken out of service. This WLL is for vertical lifts only.

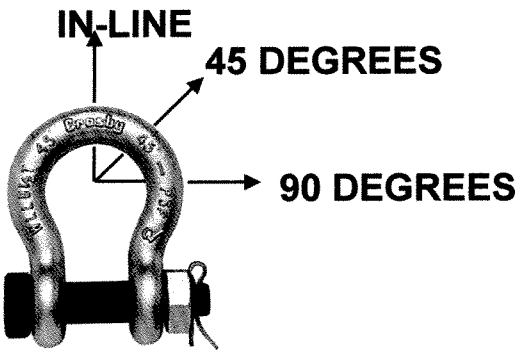
Only two types of shackles are to be used in rigging for lifts. The screw pin type and the bolt type shackle.

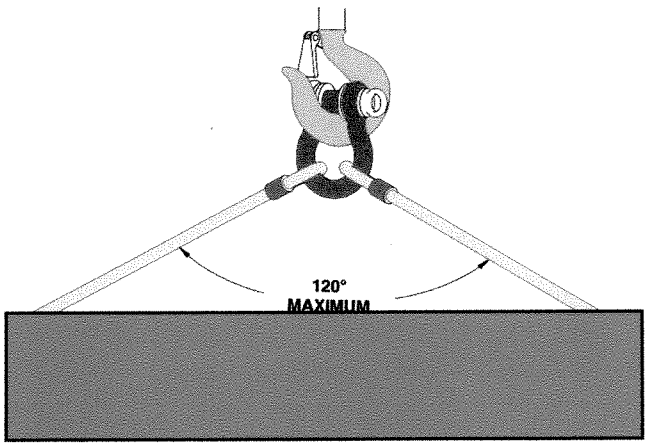






Shackles that are deformed or damaged must be removed from service.





Side Loading Reduction Chart For Screw Pin & Bolt Type Shackles Only†	
Angle of Side Load	***Adjusted Working Load Limit***
0° In-Line	**100% of Rated Working Load Limit**
45° from In-Line	**70% of Rated Working Load Limit**
90° from In-Line	**50% of Rated Working Load Limit**

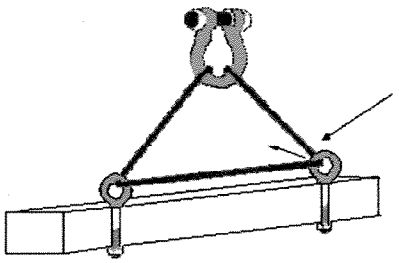
† DO NOT SIDE LOAD ROUND PIN SHACKLES

EYE BOLTS

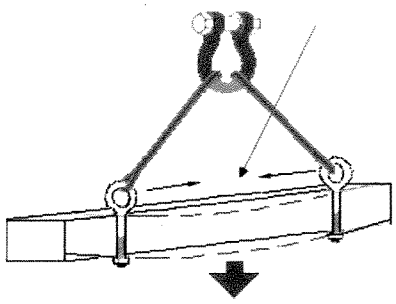
Eye bolts should always be inspected before use. Look for signs of wear and damage. Look to see if shank is bent or elongated. Make sure the threads on the shank and the receiving hole are clean.

DIRECTION OF PULL	ADJUSTED WORKING LOAD
In-Line	Full Rated Working Load
45 Degrees	30% of Rated Working Load
60 Degrees	60% of Rated Working Load

- Always use Shouldered Eye Bolts for angular lifts.
- For angular lifts, reduce working load according to chart.
- Never exceed load limits.
- Always screw eye bolt down completely for proper seating.
- Always tighten nuts securely against the load.
- Always stand clear of load when lifting.
- Always lift load with steady, even pull- do not jerk.
- Do not reeve slings from one eye bolt to another.
- Never machine, grind or cut the eye bolt.

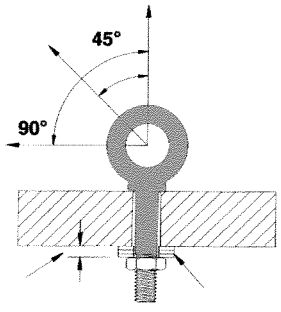


WRONG!



CAUTION

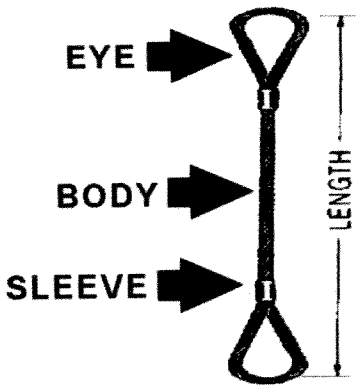
STRUCTURE MAY BUCKLE FROM COMPRESSION FORCES



Shoulder Nut
Eye Bolt

WIRE ROPE SLING INSPECTION

KINKING
CRUSHING
UNSTRANDING
BIRDCAGING
STRAND DISPLACEMENT
CORE PROTRUSION
CORROSION
BROKEN OR CUT STRANDS
BROKEN WIRES

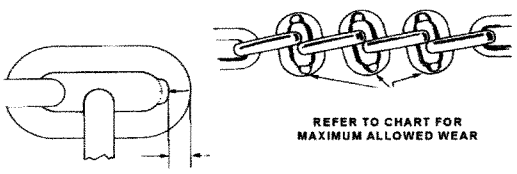


Wire rope slings need to be inspected in the same way wire rope is and a **record kept of those inspections**. All slings must have a tag on them indicating the capacity or they must be taken out of service.

Chain slings are to be inspected regularly and a record kept of these inspections also. Again, if there is no capacity tag, it must be taken out of service.
Chain slings are often used to hold steel while it is being welded. Always check to make sure heat damage has not occurred. Heat damage can be detected by discolored metal.

CHAIN SLINGS
CAUSE FOR REMOVAL
DEFORMATION AND STRETCH

CHAIN SLINGS
CAUSE FOR REMOVAL
WEAR



CHAIN SLINGS
CAUSE FOR REMOVAL
CRACKS, NICKS AND GOUGHES

SHARP TRANSVERSE NICKS AND GOUGES SHOULD BE ROUNDED OUT BY GRINDING, DO NOT EXCEED WEAR ALLOWANCE

SYNTHETIC SLING INSPECTION

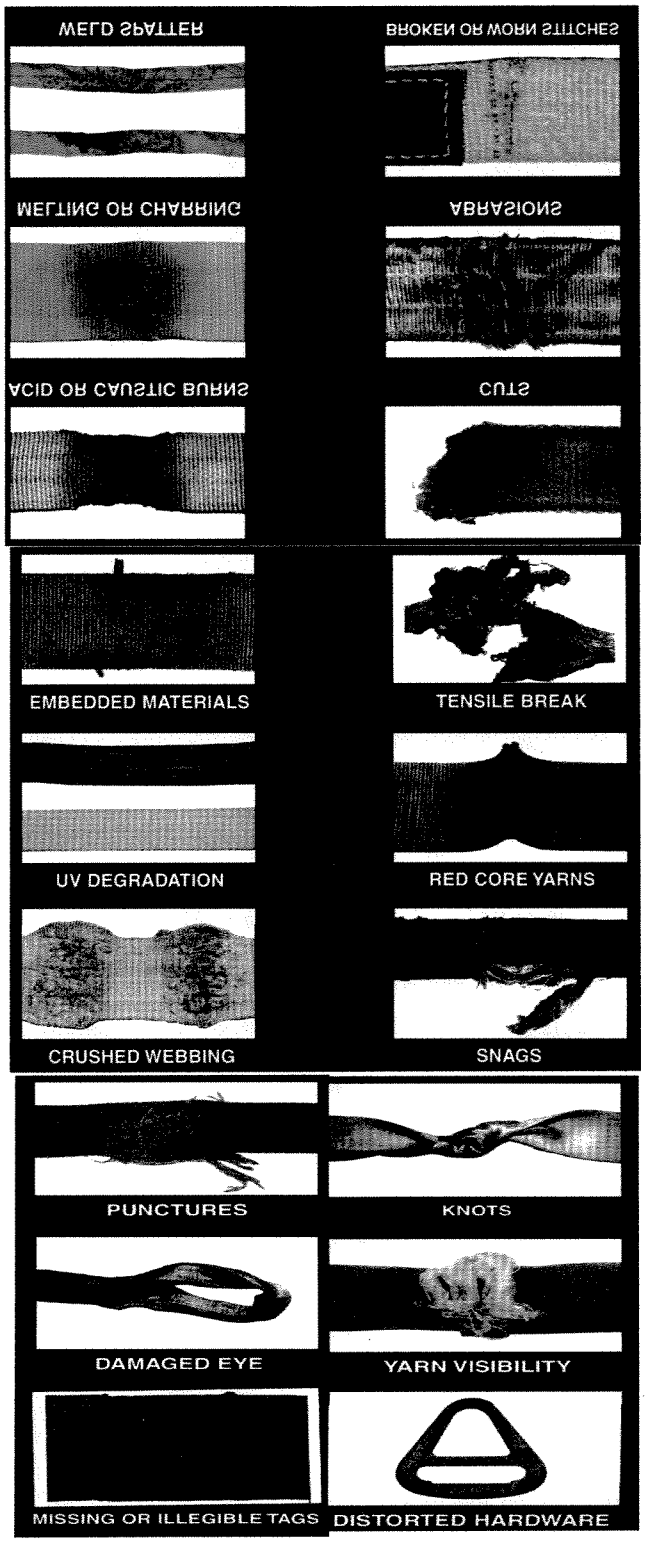
Far too many web slings have to be discarded prematurely simply because abusive or careless work habits caused irreparable damage.

To the right are some examples of damaged slings.

Regardless of whether a sling shows damage from abuse or regular wear, the overriding rule in all cases is that the sling eyes should be cut, and the sling discarded immediately whenever damage is detected.

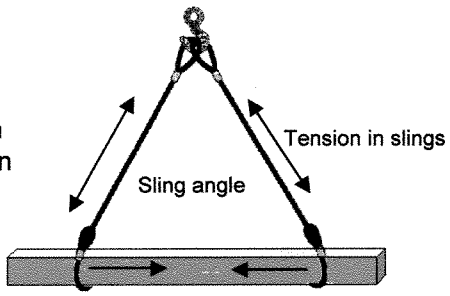
When using synthetic slings, remember:

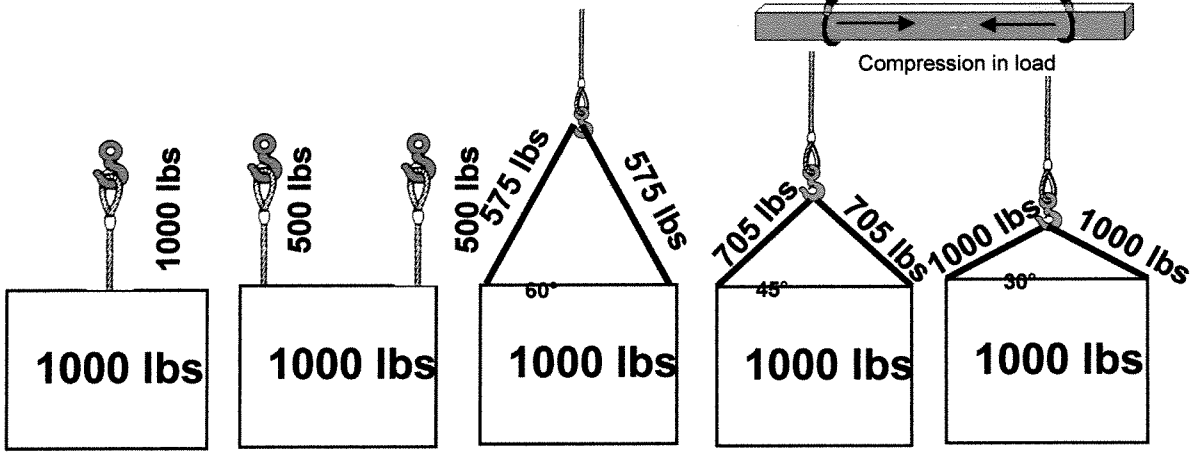
- Slings without a capacity tag should be discarded. That tag should have the following information:
  - -Name and trademark of manufacturer.
  - -Manufacturer's code or stock number.
  - -Rated loads (rated capacities) for the type of hitches used.
  - -Type of synthetic material.
- Use wear pads on corners to protect the sling from cuts, or abrasions.
- Do not pull the sling out from under the load if caught under it.
- Take into consideration the sling angles when calculating the capacity of the sling to handle the load.



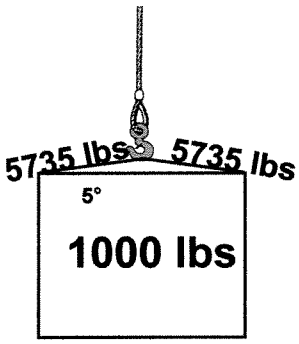
SLING ANGLES

When slings are brought together and form a hitch, as shown at right, the stresses in the slings increase and a compression force on the load is created. As the sling angle decreases, the stresses in the sling and on the load increase.





Sling angles of 60 degrees are the best to use because of the minimal increase of stress in the slings. When required to use smaller sling angles, slings need to be selected based on the increased stress and not on the weight of the load. The compression in the load also has to be considered. When the sling angle is 30 degrees for a 1000 lb load, the compression which is crushing the load will be 866 lbs. Depending on the structural strength of the load, it may be damaged.

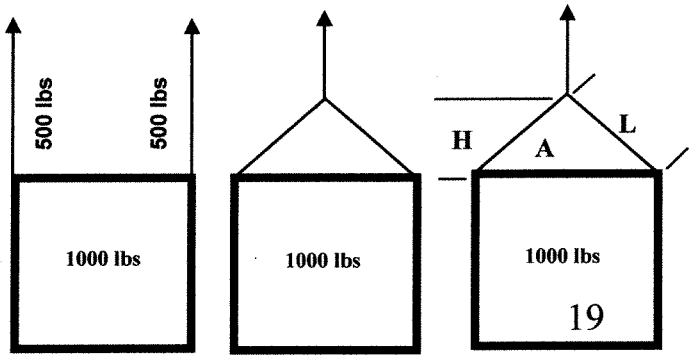


All that is needed to calculate the stress in a sling is the weight of the object and a measuring tape.

Load in each sling =
500 x Load Angle Factor

Example:
If the sling was 8' long and the height (H) was 4', then 8 divided by 4 equals 2 which equals the **Load Angle Factor**. So, if the load is 1000lbs, each sling is required to support 500lbs. The stress in the sling is equal to 500lbs x the load angle factor of 2 or 1000lbs.

Sling Angle Degree (A)	Load Angle Factor = L/H
90	1.000
60	1.155
50	1.305
45	1.414
30	2.000
Load On Each Leg Of Sling = (Load/2 x Load Angle Factor	



Calculating Load Weight

To find the weight of any item you need to know its volume and unit weight.

- Volume x Unit weight = Load weight
- Unit weight is the density of the material

Here are some examples of common materials and their unit weight:

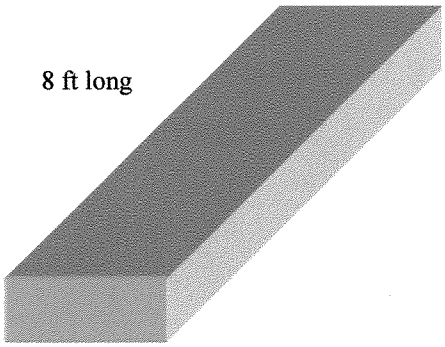
WEIGHTS OF MATERIALS BASED ON VOLUME (lbs. per cubic ft.)

MATERIAL	UNIT WEIGHT	MATERIAL	UNIT WEIGHT
METALS		**TIMBER**	
Aluminum	165	Cedar	34
Brass	535	Cherry	36
Bronze	500	Fir, seasoned	34
Copper	560	Fir, wet	50
Iron	480	Hemlock	30
Lead	710	Maple	53
Steel	490	Oak	62
Tin	460	Pine	30
MASONARY		Poplar	30
Ashlar masonry	160	Spruce	28
Brick, soft	110	White pine	25
Brick, pressed	140	Railroad ties	50
Clay tile	60	**LIQUIDS**	
Rubble masonry	155	Diesel	52
Concrete, cinder, haydite	110	Gasoline	45
Concrete, slag	130	Water	64
Concrete, stone	144	**EARTH**	
Concrete, reinforced	150	Earth, wet	100
MISC.		Earth, dry	75
Asphalt	80	Sand and gravel, wet	120
Glass	160	Sand and gravel, dry	105

Calculating Load Weight

Calculating Volume

Volume of a Cube



Length x Width x Height = Volume

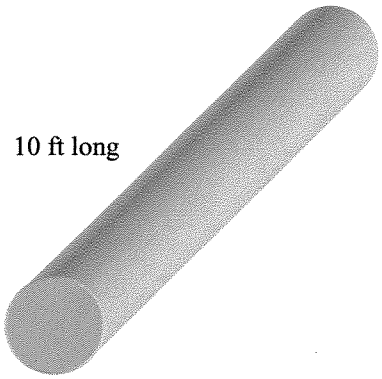
8 ft x 4 ft x 2 ft = 64 cubic feet

If the material was **cedar**, then all we need to do to determine it's weight would be to multiply the unit weight of cedar x 64.

Unit weight x Volume = Weight

34 lbs per cubic foot X 64 cubic ft. = 2,176 lbs.

Volume of a Cylinder



Pi (π) x Radius Squared x Length = Volume

π = 3.14

3.14 x 1^2 ft x 10 ft = 31.4 cubic ft

If the material was **reinforced concrete,** then all we need to do to determine it's weight would be to multiply the unit weight of reinforced concrete x 31.4.

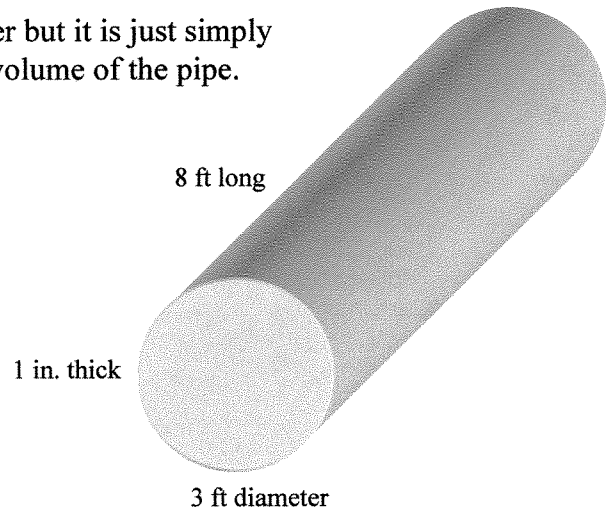
150 lbs per cubic foot x 31.4 cubic ft. = 4,710 lbs.

Calculating Load Weight

Volume of Pipe

Calculating the volume of pipe is a bit trickier but it is just simply subtracting the volume of the hole from the volume of the pipe.

If the pipe were one inch thick, three feet in diameter and 8 feet long, then we would figure the volume of the entire pipe and subtract the volume of the hole to get the the volume of the material.



3.14 x (1 ½ ft.)^2 x 8 feet = total volume of pipe (56.52 ft^3)

3.14 x (1ft 5 in.)^2 x 8 feet = volume of hole (50.41 ft^3)

56.52 ft^3 – 50.41 ft^3 = 6.11 ft^3

Volume of material x unit weight = total weight

If this pipe were **steel** then the unit weight would be 490 lbs.

6.11 x 490 lbs = 2,994 lbs.

For thin pipe a quick way to *ESTIMATE the volume is to split the pipe open and calculate the volume like a cube. The formula would be:

π x diameter = width, so:

π x diameter x length x thickness x unit weight = weight of object

3.14 x 3 ft x 8 ft x 1/12 ft (or .008 ft) x 490 lbs = *3,077.2 lbs

Calculating Load Weight

WEIGHT TABLES

Weight tables are an excellent way to calculate load weight. If you are handling certain materials often, then having a chart that gives you the weight per cubic foot, cubic yard, square foot, linear foot or per gallon is handy. Here are a few examples:

METAL PLATES

1 INCH STEEL PLATE weighs approximately 40 lbs per sq. ft. 1/2 inch steel plate would then be about 20 lbs. per sq. ft.

A steel plate measuring 8 ft. x 10 ft. x 1inch would then weigh about 3,200 lbs. (8 x 10 x 40 lbs = 3,200 lbs.)

BEAMS

Beams come in all kinds of materials and shapes and lengths. STEEL I-BEAMS weigh approximately 40 lbs a linear ft. at 1/2 inch thick and 8 inches x 8 inches. If it were 1 inch thick then it would be 80 lbs a linear ft. If it were 20 feet long at 1 inch thick then it would weigh about 1,600 lbs. (20 ft. x 80 lbs. = 1,600lbs.)

There are weight tables for everything from creosoted pine poles to steel coils. Take advantage of these. But, if you don't know for sure the weight of a load and there are no other resources available to help you, don't hesitate to do the calculations yourself.

Calculating Load Weight Review

USING THE FORMULAS AND WEIGHT TABLES FROM THE PREVIOUS PAGES, CALCULATE THE WEIGHT OF THE FOLLOWING OBJECTS:

1. **A load of cedar 4" x 4" x 8' posts. The stack is 3' high and 4' wide.**

   a. 6,528 lbs.
   b. 3,264 lbs.
   c. 1,632 lbs.
   d. not enough information was given.

2. **A concrete pipe 1' thick, 4' in diameter and 12' long.**

   a. 33,930 lbs.
   b. 8,482 lbs.
   c. 16,965lbs.
   d. 1,696.5 lbs.

3. **A steel plate that is 1" thick x 8' x 12'.**

   a. 3,840 lbs.
   b. 6,550 lbs.
   c. 1,920 lbs.
   d. none of the above.

4. **An 1" thick I-beam that is 8" x 8" x 12 ft long.**

   a. 9,600 lbs.
   b. 6,300 lbs.
   c. 1,820 lbs.
   d. 960 lbs.

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