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Sling Safety

The ability to handle materials-to move them from one location to another, whether during transit or at the worksite-is vital to all segments of industry. Materials must be moved, for example, for industry to manufacture, sell, and utilize products. In short, without materials-handling capability, industry would cease to exist.

To varying degrees, all employees in numerous workplaces take part in materials handling. Consequently, some employees are injured. In fact, the mishandling of materials is the single largest cause of accidents and injuries in the workplace. Most of these accidents and injuries, as well as the pain and loss of salary and productivity that often result, can be readily avoided. Whenever possible, mechanical means should be used to move materials to avoid employee injuries such as muscle pulls, strains, and sprains. In addition, many loads are too heavy and/or bulky to be safely moved manually. Various types of equipment, therefore, have been designed specifically to aid in the movement of materials: cranes, derricks, hoists, powered industrial trucks, and conveyors.

Because cranes, derricks, and hoists rely upon slings to hold their suspended loads, slings are the most commonly used materials handling apparatus. This booklet offers information on the proper selection, maintenance, and use of slings.

Importance of the Operator

The operator must exercise intelligence, care, and common sense when selecting and using slings. Slings must be selected in accordance with their intended use, based upon the size and type of load, and the environmental conditions of the workplace. All slings must be visually inspected before use to ensure their effectiveness.

A well-trained operator can prolong the service life of equipment and reduce costs by avoiding the potentially hazardous effects of overloading equipment, operating it at excessive speeds, taking up slack with a sudden jerk, and suddenly accelerating or decelerating equipment. The operator can look for causes and seek corrections whenever a danger exists. He or she should cooperate with coworkers and supervisors and become a leader in carrying out safety measures-not merely for the good of the equipment and the production schedule but, more importantly, for the safety of everyone concerned.

Sling Types

The dominant characteristics of a sling are determined by the components of that sling. For example, the strengths and weaknesses of a wire rope sling are essentially the same as the strengths and weaknesses of the wire rope of which it is made.

Slings are generally one of six types: chain, wire rope, metal mesh, natural fiber rope, synthetic fiber rope, or synthetic web. In general, use and inspection procedures tend to place these slings into three groups: chain, wire rope and mesh, and fiber rope web. Each type has its own particular advantages and disadvantages. Factors to consider when choosing the best sling for the job include the size, weight, shape, temperature, and sensitivity of the material to be moved, as well as the environmental conditions under which the sling will be used.

Chains

Chains are commonly used because of their strength and ability to adapt to the shape of the load. Care should be taken, however, when using alloy chain slings because sudden shocks will damage them. Misuse of chain slings could damage the sling, resulting in sling failure and possible injury to an employee.

Chain slings are the best choice for lifting very hot materials. They can be heated to temperatures of up to 1,000° Fahrenheit (538° centigrade); however, when alloy chain slings are consistently exposed to service temperatures in excess of 600° Fahrenheit (3 16° centigrade), operators must reduce the working load limits in accordance with the manufacturer's recommendations.

All sling types must be visually inspected prior to use. When inspecting alloy steel chain slings, pay special attention to any stretching, wear in excess of the allowances made by the manufacturer, and nicks and gouges. These signs indicate that the sling may be unsafe and they must be removed from service.

Wire Rope

A second type of sling is made of wire rope. Wire rope is composed of individual wires that have been twisted to form strands. Strands are then twisted to form a wire rope. When wire rope has a fiber core, it is usually more flexible but is less resistant to environmental damage. Conversely, a core that is made of a wire rope strand tends to have greater strength and is more resistant to heat damage.

Wire rope may be further defined by the "lay." The lay of a wire rope describes the direction the wires and strands are twisted during the construction of the rope. Most wire rope is right lay, regular lay-which means that the strands pass from left to right across the rope and the wires in the rope are laid *opposite* in direction to the lay of the strands. This type of rope has the widest range of applications.

Lang lay (where the wires are twisted in the same direction as the strands) is recommended for many excavating, construction, and mining applications, including draglines, hoist lines, dredgelines, and other similar lines.

Lang lay ropes are more flexible and have greater wearing surface per wire than regular lay ropes. In addition, since the outside wires in lang lay rope lie at an angle to the rope axis, internal stress due to bending over sheaves and drums is reduced causing lang lay ropes to be more resistant to bending fatigue.

A left lay rope is one in which the strands form a left-hand helix similar to the threads of a left-hand screw thread. Left lay rope has its greatest usage in oil fields on rod and tubing lines, blast hole rigs, and spudders where rotation of right lay would loosen couplings. The rotation of a left lay rope tightens a standard coupling.

Wire Rope Sling Selection. When selecting a wire rope sling to give the best service, there are four characteristics to consider: strength, ability to bend without distortion, ability to withstand abrasive wear, and ability to withstand abuse.

1. Strength-The strength of a wire rope is a function of its size, grade, and construction. It must be sufficient to accommodate the applied maximum load. The maximum load limit is determined by means of an appropriate multiplier. This multiplier is the number by which the ultimate strength of a wire rope is divided to determine the working load limit. Thus, a wire rope sling with a strength of 10,000 pounds (4,545 kilograms) and a total working load of 2,000 pounds (909 kilograms) has a design factor (multiplier) of 5. New wire rope slings have a design factor of 5. As a sling suffers from the rigors of continued service, however, both the design factor and the sling's ultimate strength are proportionately reduced. If a sling is loaded beyond its ultimate strength, it will fail. So, older slings must be more rigorously inspected to ensure that rope conditions adversely affecting the strength of the sling are considered in determining if a wire rope sling should be allowed to continue in service.

2. Fatigue (Bending without Failure)-A wire rope must have the ability to withstand repeated bending without the wires failing from fatigue. Fatigue failure of the wires in a wire rope is the result of the development of small cracks from repeated applications of bending loads. It occurs when ropes make small radius bends. The best means of preventing fatigue failure of wire rope slings is to use blocking or padding to increase the radius of bend.

3. Abrasive Wear-The ability of a wire rope to withstand abrasion is determined by the size, number of wires, and construction of the rope. Smaller wires bend more readily and therefore offer greater flexibility but are less able to withstand abrasive wear. Conversely, the larger wires of less flexible ropes are better able to withstand abrasion than are the smaller wires of more flexible ropes.

4. Abuse-All other factors being equal, misuse or abuse of wire rope will cause a wire rope sling to become

unsafe long before any other factor. Abusing a wire rope sling can cause serious structural damage to the wire rope, such as kinking or bird caging, which reduces the strength of the wire rope. (In bird caging, the wire rope strands are forcibly untwisted and become spread outward.) So, to prolong the life of the sling and protect the lives of employees, the manufacturer's suggestion for safe and proper use of wire rope slings must be strictly adhered to.

Wire Rope Life. Many operating conditions affect wire rope life. They are bending, stresses, loading conditions, speed of load application (jerking). abrasion, corrosion, sling design, materials handled, environmental conditions, and history of previous usage.

In addition to the above operating conditions, the weight, size, and shape of the loads to be handled also affect the service life of a wire rope sling. Flexibility also is a factor. Generally, more flexible ropes are selected when smaller radius bending is required. Less flexible ropes should be used when the rope must move through or over abrasive materials.

Wire Rope Sling Inspection. Wire rope slings must be visually inspected before each day's use. The operator should check the twists or lay of the sling. If ten randomly distributed wires in one lay are broken, or five wires in one strand of a rope lay are damaged, the sling must not be used. It is not sufficient, however, to check only the condition of the wire rope. End fittings and other components should also be inspected for any damage that could make the sling unsafe.

To ensure safe slings: usage between scheduled inspections, all workers should participate in a safety awareness program. Each operator should keep a close watch on those slings he or she is using. If any accident involving the movement of materials occurs, the operator should immediately shut down the equipment and report the accident to a supervisor. The cause of the accident should be determined and corrected before resuming operations.

Field Lubrication. Although every rope sling is lubricated when manufactured, it also must be lubricated "in the field" to increase the sling's useful service life. There is no set rule on how much or how often this should be done. It depends on the conditions under which the sling is used. The heavier the loads, the greater the number of bends, or the more adverse the conditions under which the sling operates, the more frequently lubrication is required.

Storage. Wire rope slings should be stored in a well-ventilated, dry building or shed. To avoid corrosion and rust, never store wire rope slings on the ground or allow them to be continuously exposed to the elements. And, if it is necessary to store wire rope slings outside, make sure that they are set off the ground and protected.

Note: Using the sling several times a week, even with light loads, is a good practice. Records show that frequently or continuously used slings give useful service far longer than idle ones.

Discarding Slings. Wire rope slings can provide a margin of safety by showing early signs of failure. The following factors indicate when a wire sling needs to be discarded:

Severe corrosion,
Localized wear (shiny worn spots) on the outside,
A one-third reduction in outer wire diameter,
Damage or displacement of end-fittings-hooks, rings, links, or collars-by overload or misapplication,
Distortion, kinking, bird caging, or other evidence of damage to the wire rope structure, or
Excessive broken wires.

Fiber Rope and Synthetic Web

Fiber rope and synthetic web slings are used primarily for temporary work, such as construction and painting jobs, and in marine operations. They also are the best choice for use on expensive loads, highly finished parts, fragile parts, and delicate equipment.

Fiber Rope Slings. Fiber rope deteriorates on contact with acids and caustics. Fiber ropes slings, therefore, must not be used around these substances unless the manufacturer recommends them for that use.

When inspecting a fiber rope sling, look first at its surface. Look for cuts, gouges, or worn surface areas; dry, brittle, scorched, or discolored fibers; or melting or charring of any part of the sling. If any of these conditions are found, the supervisor must be notified and a determination made regarding the safety of the sling. If the

sling is found to be unsafe, it must be discarded.

Next, check the sling's interior. It should be as clean as when the rope was new. A buildup of powderlike sawdust on the inside of the fiber rope indicates excessive internal wear and that the sling is unsafe.

Finally, scratch the fibers with a fingernail. If the fibers separate easily, the fiber sling has suffered some kind of chemical damage and must be discarded.

Synthetic Rope and Web Slings. The most commonly used synthetic web slings are made of nylon, polypropylene, and polyester. They have the following properties in common:

Strength--can handle a load of up to 300,000 pounds (1 36,363 kilograms).
Convenience-can conform to any shape.
Safety-will adjust to the load contour and hold it with a tight, non-slip grip.
Load protection-will not mar, deface, or scratch highly polished or delicate surfaces.
Long life-are unaffected by mildew, rot, or bacteria; resist some chemical action; and have excellent abrasion resistance.
Economy-have a low initial cost plus a long service life.
Shock absorbency--can absorb heavy shocks without damage.
Temperature resistance-are unaffected by temperatures up to 180" Fahrenheit (82.2" centigrade).

Because each synthetic material has unique properties, it should be used according to the manufacturer's instructions, especially when dealing with chemically active environments.

Possible Defects. Synthetic web slings must be removed from service if any of the following defects exist:

Acid or caustic burns,
Melting or charring of any part of the surface,
Snags, punctures, tears, or cuts,
Broken or worn stitches,
Wear or elongation exceeding the amount recommended by the manufacturer, or
Distortion of fittings.

Safe Lifting Practices

Now that the sling has been selected (based upon the characteristics of the load and the environmental conditions surrounding the lift) and inspected prior to use, the next step is learning how to use it safely. There are four primary factors to consider when safely lifting a load. They are (1) the size, weight, and center of gravity of the load; (2) the number of legs and the angle the sling makes with the horizontal line; (3) the rated capacity of the sling; and (4) the history of the care and usage of the sling.

Size, Weight, and Center of Gravity of the Load

The center of gravity of an object is that point at which the entire weight may be considered as concentrated. To make a level lift, the crane hook must be directly above this point. While slight variations are usually permissible, if the crane hook is too far to one side of the center of gravity, dangerous tilting will result causing unequal stresses in the different sling legs. This imbalance must be compensated for at once.

Number of Legs and Angle with the Horizontal

As the angle formed by the sling leg and the horizontal line decreases, the rated capacity of the sling also decreases. In other words, the smaller the angle between the sling leg and the horizontal, the greater the stress on the sling leg and the smaller (lighter) the load the sling can safely support. Larger (heavier) loads can be safely moved if the weight of the load is distributed among more sling legs.

Rated Capacity of the Sling

The rated capacity of a sling varies depending upon the type of sling, the size of the sling, and the type of hitch. Operators must know the capacity of the sling. Charts or tables that contain this information generally are available from sling manufacturers. The values given are for new slings. Older slings must be used with additional caution. Under no circumstances shall a sling's rated capacity be exceeded.

History of Care and Usage

The mishandling and misuse of slings are the leading cause of sling-related accidents. The majority of injuries and accidents, however, can be avoided by becoming familiar with the essentials of proper sling care and use.

Proper care and use are essential for maximum service and safety. Slings must be protected with cover saddles, burlap padding, or wood blocking as well as from unsafe lifting procedures such as overloading to prevent sharp bends and cutting edges.

Before making a lift, check to be certain that the sling is properly secured around the load and that the weight and balance of the load have been accurately determined. If the load is on the ground, do not allow the load to drag along the ground. This could damage the sling. If the load is already resting on the sling, ensure that there is no sling damage prior to making the lift.

Next, position the hook directly over the load and seat the sling squarely within the hook bowl. This gives the operator maximum lifting efficiency without bending the hook or overstressing the sling.

Wire rope slings also are subject to damage resulting from contact with sharp edges of the loads being lifted. These edges can be blocked or padded to minimize damage to the sling.

After the sling is properly attached to the load, there are a number of good lifting techniques that are common to all slings. First, make sure that the load is not lagged, clamped, or bolted to the floor. Second, guard against shock loading by taking up the slack in the sling slowly. Apply power cautiously to prevent jerking at the beginning of the lift, and slowly accelerate or decelerate. Third, check the tension on the sling. Raise the load a few inches, stop, and check for proper balance and that all items are clear of the path of travel. Never allow anyone to ride on the hood or load. Fourth, keep all personnel clear while the load is being raised, moved, or lowered. Crane or hoist operators should watch the load at all times when it is in motion. Finally, obey the following "nevers:" **Never** allow more than one person to control a lift or give signals to a crane or hoist operator except to warn of a hazardous situation. **Never** raise the load more than necessary. **Never** leave the load suspended in the air. And **never** work under a suspended load or allow anyone else to.

Once the lift has been completed, clean the sling, check it for damage, and store it in a clean, dry airy place. It is best to hang it on a rack or wall.

Remember, damaged slings cannot lift as much weight as new or older well-cared for slings. Proper and safe use and storage of slings will increase their service life.

Maintenance of Slings

Chains

Chain slings must be cleaned prior to each inspection, as dirt or oil may hide damage. The operator must be certain to inspect the total length of the sling, periodically looking for stretching, binding, wear, or nicks and gouges. If a sling has stretched so that it is now more than three percent longer than when it was new, it is unsafe and must be discarded.

Binding is the term used to describe the condition that exists when a sling has become deformed to the extent that its individual links cannot move within each other freely. It indicates that the sling is unsafe. Generally, wear occurs on the load-bearing inside ends of the links. Pushing links together so that the inside surface becomes clearly visible is the best way to check for this type of wear. Wear may also occur, however, on the outside of links when the chain is dragged along abrasive surfaces or pulled out from under heavy loads. Either type of wear weakens slings and makes accidents more likely.

Heavy nicks and/or gouges must be filed smoothly, measured with calipers, and then compared with the manufacturer's minimum allowable safe dimensions. When in doubt, or in borderline situations, do not use the sling. In addition, never attempt to repair the welded components on a sling. If the sling needs repair of this nature, the supervisor must be notified.

Wire Rope

Wire rope slings, like chain slings, must be cleaned prior to each inspection because they are subject to damage hidden by dirt or oil. In addition, they must be lubricated according to manufacturer's instructions. Lubrication prevents or reduces corrosion and wear due to friction and abrasion. Before applying any lubricant, however,

the sling user should make certain that the sling is dry. Applying lubricant to a wet or damp sling traps moisture against the metal and hastens corrosion.

Corrosion deteriorates wire rope. It may be indicated by pitting, but it is sometimes hard to detect. If a wire rope sling shows any sign of significant deterioration, that sling must be removed until can be examined by a person who is qualified to determine the extent of the damage.

By following the above guidelines to proper sling use and maintenance, and by the avoidance of kinking, it is possible to greatly extend the useful service life of a wire rope sling.

Fiber and Synthetic Ropes

Fiber ropes and synthetic webs are generally discarded rather than serviced or repaired. Operators must always follow the manufacturer's recommendations.

Summary

There are good practices to follow to protect yourself while using slings to move materials. First, accept the responsibility for your own actions. Become a competent and careful employee. Your own life or that of your fellow workers or others may depend on it. Second, learn as much as you can about the materials with which you will be working. Slings come in many different types, one of which is right for your purpose. Third, analyze the load to be moved-in terms of size, weight, shape, temperature, and sensitivity then choose the sling which best meets those needs. Fourth, always inspect all the equipment before and after a move. Always be sure to give equipment whatever "in service" maintenance it may need. Fifth, use safe lifting practices. Use the proper lifting technique for the type of sling and the type of load.