Sling Safety

An Online Continuing Education Course for Engineers

Course Number: C-1021

Credit: 1 Hour / 1 PDH / 1 CPD

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Introduction

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 course 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.

What OSHA Standards Apply?
Although this course discusses and makes recommendations on slings, there are legal requirements in OSHA standards that you must know about and comply with. The most important standard for you depends on the type of work you are doing:

- For general industry, follow 29 CFR 1910.184.
- For overhead and gantry cranes, follow 29 CFR 1910.179.
- For shipyards, follow 29 CFR 1915.112
- For construction industry, follow 29 CFR 1926.251.
- For marine terminals, follow 29 CFR 1917.13.
- For longshoring, follow 29 CFR 1918.81.

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 must be removed from service.

Wire Rope

Another 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 a 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 lefthand screw thread. A 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 the 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 the 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 sling: 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 accidents 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
- 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 powder-like 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 remov if any of the following defects exist:

- Acid or caustic bur
- Melting or charring
- Snags, punctures, te
- Broken or worn stitc
- Wear or elongation e cturer
- Distortion of fittings

Safe Lifting Practices

Now that the sling has b load and the environmental conditior e next step is learning how to use it sa en safely lifting a load. They are (1) the siz number of legs and the angle the sling makes e sling; and (4) the history of the care and us