

## Section 18

# Slings and Rigging Hardware

Section 18, “Slings and Rigging Hardware,” sets forth the requirements for using slings, chains, and accessories. It specifically addresses using alloy steel chains, wire rope slings, synthetic web slings, synthetic roundslings, shackles, and other rigging hardware.

## 18.1 General Requirements

**18.1.1 Standard Criteria.** The *Rigging Manual*, latest edition, published by the Construction Safety Association of Ontario, 21 Voyager Court South, Etobicoke, Ontario, Canada, M9W 5M7, is the designated Bureau of Reclamation (Reclamation) Rigging Manual. Reclamation will use this manual as a guide to determine if rigging practices are safe and conform to industry-wide practices. Although used by Reclamation and contractors, both as a rigging manual and a training text, contractually, it is advisory in nature (except where specifically referenced) and intended only to complement the safety requirements set forth in Section 18.

**18.1.2 Safe Usage.** Use of ropes, slings, and chains must conform to equipment manufacturer’s recommendations, Section 18, applicable current American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI) standards (table 18-1), and Occupational Safety and Health Administration (OSHA) regulations.

**Table 18-1.— Rigging Standards**

Standard No.	Title
ASME/ANSI B30.9	Slings
ASME/ANSI B30.10	Hooks
ASME/ANSI B30.20	Below-the-Hook Lifting Devices
ASME/ANSI B30.26	Rigging Hardware

**18.1.3 Safe Working Loads.** Determine the safe working load of slings, chains, accessories, and rigging equipment before use. The safe working loads of slings must not exceed the rated capacities or working load limit. The rated load is based upon material strength, a design safety factor, the type of hitch, and the specific angle of loading.

**18.1.4 Job-Fabricated/Purpose-Built Rigging Hardware.** A professional engineer must design and certify the use of any job-fabricated/purpose-built rigging hardware and test it at twice the rated safe working load or in accordance with applicable standards.

**18.1.5 Use, Repair, and Maintenance.** The use, repair, and maintenance of ropes, chains, slings, and rigging accessories must conform to the manufacturer's written instructions. Test repaired slings and accessories at twice their rated load before use.

**18.1.6 Protection.** Appropriately protect slings with a material of sufficient strength, thickness, and construction to prevent damage to the strands, fibers, wires, or links from sharp, rough, or square corners. Properly store slings when they are not in use to protect them from mechanical damage, corrosive action, moisture, temperature extremes, ultraviolet light, ozone, or other factors as appropriate.

## **18.2 Rigger Responsibilities**

### **18.2.1 Responsibilities of Rigger**

- a. Ensure that the rigging equipment and materials have the required capacity for the job, that all items are in good condition and are properly used, and that inspections are current.
- b. Verify that rigging equipment and material are in compliance with local written job procedures, if applicable.
- c. Confirm that the load path is clear of personnel and obstacles.
- d. Participate in the formulation of critical lift plans.

## **18.3 Qualifications for Riggers**

Only personnel who have received rigger training, have demonstrated proficiency, and have been deemed qualified will perform rigging operations. A qualified rigger is a person who possesses a recognized degree, certificate, or professional standing—or has extensive knowledge, training, and experience—and who can successfully demonstrate the ability to solve problems related to rigging loads. Initial training, and retraining at least every 5 years, are required and will be taught by a third party.

## **18.4 Inspections**

Make frequent and periodic inspections of slings and rigging hardware. Immediately remove defective equipment from service.

**18.4.1 Frequent Inspections.** The user must inspect rigging equipment before each shift.

**18.4.2 Thorough Periodic Inspections.** A designated person must thoroughly inspect slings and rigging hardware. The field location must determine the frequency of the periodic inspection on the basis of use, severity of service conditions, nature of the lifts, and experience on the service life of slings used in similar circumstances. Conduct and document inspections periodically and at least once every 12 months.

**18.4.3 Special or Infrequent Service.** For slings that are used infrequently, inspect before each use. At the time of use, document the inspection.

## 18.5 Removal from Service

Routinely inspect chain, wire rope, fiber, synthetic webbing, and sling hooks. Remove them from service if any are deformed, damaged, or otherwise do not meet inspection criteria and are not safe for use. Cut up and discard slings removed from service due to defects or plainly mark them as being unfit for load-bearing service. Do not repair cracked, broken, or bent end attachments. Damaged equipment must be replaced.

## 18.6 Availability and Retention of Records

Keep written records of periodic inspections and proof tests, identifying the type and nature of the inspection and testing. Make these records readily accessible to operating personnel and available upon request to employees or compliance officials. Records will be readily available and maintained until the next periodic/annual inspection or in accordance with Reclamation records management requirements.

## 18.7 Requirements for Using Alloy Steel Chains

**18.7.1 Safe Working Load.** Do not exceed the manufacturer's safe working load for any configuration. When heated in excess of 400 degrees Fahrenheit (°F), or used in temperatures below -40 °F, adjust the chain's safe working capacity to conform to the manufacturer's instructions.

**18.7.2 Grade.** In hoisting operations, use only heat-treated alloy steel chains that meet at least grade 80. Each link of heat-treated alloy steel chains must be marked with an "A," "T," or "8." The marking designates heat-treated alloy steel meeting at least grade 80.

**18.7.3 Identification.** Durable identification tags must be permanently affixed to welded alloy steel chain slings. The tags must state the size, grade,

number of legs, rated load for at least one hitch type at the angle upon which it is based, length (reach), identification or serial number, and sling manufacturer.

**18.7.4 Accessories.** The rated capacity of hooks, rings, links, or other attachments used with alloy steel chains must at least equal that of the chains. Do not use job-made hooks, links, or makeshift fasteners made from bolts or rods.

**18.7.5 Impact Loading.** Do not subject chains to impact loading.

**18.7.6 Excessive Wear.** Whenever the wear at any point in any chain link, or the depth of gouge or rounded out portion, exceeds the measurements in table 18-2, remove it from service. Use a device capable of measuring to one one-thousandth of an inch to measure chain wear. Remove any sharp nicks by hand filing.

**Table 18-2.—Minimum Allowable Thickness on a Link**

Original nominal chain stock diameter (inches)	Minimum allowable thickness at any point on a link (inches)
7/32 = 0.219	0.189
9/32 = 0.281	0.239
5/16 = 0.313	0.273
3/8 = 0.375	0.342
1/2 = 0.500	0.443
5/8 = 0.625	0.546
3/4 = 0.750	0.687
7/8 = 0.875	0.750
1 = 1.000	0.887
1-1/4 = 1.250	1.091

**18.7.7 Removal from Service.** Remove from service any assemblies with deformed master or coupling links or cracked hooks or attachments. Permanently remove from service alloy steel chains heated above 1,000 °F, and reduce their capacities if exposed to temperatures at or above 400 °F.

**18.7.8 Proof Testing.** When repaired, a chain sling must be permanently marked to identify the repairing agency. Before use, proof test each new, repaired, or reconditioned alloy steel chain sling and all welded parts in the sling assembly to twice the rated capacity. Make a copy of the proof test certificate, including the date and weight, and make the records available for examination.

## 18.8 Requirements for Using Wire Rope Slings

**18.8.1 Safe Working Load.** Do not exceed the manufacturer's safe working load for any configuration. For angles other than those shown on the manufacturer's tag, use the rated load for the next lower angle, or a qualified person shall calculate the load.

**18.8.2 Grade.** Wire rope slings covered by Subsection 18.8, "Requirements for Using Wire Rope Slings," are based on nominal wire rope strength as shown in Federal Specification RR-W-410, "Wire Rope and Strand," and Military Specification MIL-W-83420, "Wire Rope, Flexible, for Aircraft Control" (except for fatigue requirements). Wire rope will be manufactured and tested in accordance with American Society for Testing Materials (ASTM) A 1023/A 1023M, "Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes," and ASTM A586, "Standard Specification for Zinc-Coated Parallel and Helical Steel Wire Structural Strand and Zinc-Coated Wire for Spun-in-Place Structural Strand."

**18.8.3 Identification.** Each sling will be marked to show the trademark or manufacturer, diameter or size, and safe working load for at least one hitch and the angle upon which it is based, and number of legs if there is more than one leg. If the wire rope sling identification tag is missing or it is illegible, send it back to the manufacturer for recertification and identification, or replace it with a new sling.

**18.8.4 Proof Test.** Proof test all job-made or repaired slings. Proof test all swaged socket and poured socket assemblies to the wire rope or fitting manufacturer's recommendations but, in no case, to more than 50 percent of the component wire ropes' minimum breaking strength. The proof test for a single-leg, hand-tucked sling must be at least 1 time to a maximum of 1.25 times the rated load. The proof test for mechanical splice single-leg slings and endless slings must be 2 times the vertical load. Apply the proof load for multiple-leg bridle slings to the individual legs at 1 to 1.25 times the rated vertical load for hand tucked splice, or 2 times the rated vertical load for mechanical splice. Load any master link connected to multiple-leg slings to 2 times the force of the combined legs. Make a copy of the proof test certificate, including the date and weight, and make the records available for examination.

**18.8.5 Environmental Effects.** Do not expose fiber core wire rope slings to temperatures above 180 °F. Consult sling manufacturers before using slings in chemically active environments or in temperatures above 400 °F or below -40 °F.

**18.8.6 End Fittings and Connections.** Do not form eyes in wire rope slings or chokers with wire clips or a fold back eye with pressed metal sleeve.

**18.8.7 Protruding Ends.** Cover or blunt protruding ends of strands in splices on slings and bridles.

**18.8.8 Sling Inspection and Replacement.** Inspect slings periodically and remove them from service if one or more of the following conditions are present:

- a. Missing or illegible sling identification
- b. Ten randomly distributed broken wires in one rope lay, or five broken wires in one strand in one rope lay.
- c. Wear or scraping on one-third of the original diameter of outside individual wires.
- d. Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- e. Evidence of heat damage.
- f. Hooks that have any visibly apparent bend or twist from the plane of the unbent hook or an increase in the throat opening of 5 percent, and not to exceed ¼ inch.
- g. Cracked, deformed, or worn end attachments.
- h. Corrosion of the rope or end attachments.
- i. Evidence of unauthorized alterations such as drilling, machining, grinding, or other modifications.

Permanently remove from service fiber core rope slings if exposed to temperatures above 180 °F. Nonfiber core rope temperatures must not exceed 400 °F or -40 °F with manufacturer's recommendation.

## **18.9 Requirements for Using Synthetic Web Slings**

**18.9.1 Synthetic Webbing.** Synthetic webbing will be manufactured and tested in accordance with Web Sling & Tie Down Association standards.

**18.9.2 Safe Working Load.** Do not use a webbing sling at a load greater than the manufacturer's established safe working load. Follow the manufacturer's recommended safe working load for the specific angle of loading.

**18.9.3 Identification.** Synthetic web slings must be marked or coded with the manufacturer's name or trademark, code or stock number, type of material,

the rated capacity for the type of hitches used, and number of legs if there is more than one leg.

#### **18.9.4 Care and Maintenance**

**a. Webbing.** Synthetic webbing must be of uniform thickness and width; do not split selvage edges from the webbing's width.

**b. Fittings.** The minimum breaking strength of fittings must equal twice the rated load of the sling, and the fittings must be free of all sharp edges that could damage the webbing.

**c. Storage and Use.** Do not use or store nylon web, polyester, and polypropylene web slings and web slings with aluminum fittings where caustic fumes, vapors, sprays, mists, or liquids are present. Store slings out of direct sunlight to avoid deterioration from ultraviolet light, away from sources of ozone generation, and protect them from mechanical damage

**d. Temperature.** Do not use synthetic web slings of polyester and nylon in temperatures above 180 °F or below -40 °F. Do not use polypropylene web slings in temperatures above 200 °F.

**18.9.5 Removal from Service.** Immediately remove synthetic web slings from service if one or more of the following visible defects are present:

- a. Missing or illegible sling identification.
- b. Acid or caustic burns.
- c. Melting or charring of any part of the surface.
- d. Snags, punctures, tears, or cuts.
- e. Broken or worn stitches.
- f. Wear or elongation exceeding the amount recommended by the manufacturer.
- g. Fittings that are pitted, corroded, cracked, gouged, broken, or distorted.
- h. Knots in any part of the sling.

**18.9.6 Repairs.** Do not use repaired synthetic web slings unless a sling manufacturer, or an equivalent entity, repairs them. Proof test each repaired sling to twice the rated load before returning it to service. Maintain documentation of the proof test.

## 18.10 Requirements for Synthetic Roundslings

**18.10.1 Composition.** Core yarn will be of a synthetic fiber, and the cover will be woven from synthetic yarns. The thread used in synthetic roundslings will be manufactured and tested in accordance with Web Sling & Tie Down Association standards.

**18.10.2 Safe Working Load.** The safe working load for single-leg polyester roundslings must conform to the values shown in appendix E, table E-21. Load capacities are in the temperature range of -40 °F to 194 °F. When using roundslings in temperatures outside this range, in chemical environments, or when they are constructed with yarns of nonpolyester materials, consult the sling manufacturer.

**18.10.3 Identification.** Each roundsling must be tagged to show the manufacturer's name or trademark, code or stock number, type of material in the core and cover (if different), the rated capacity for the type of hitches used, and the number of legs if there is more than one leg.

**18.10.4 Removal from Service.** Immediately remove roundslings from service if any of the following conditions are present:

- a. Missing or illegible sling identification.
- b. Acid or caustic burns.
- c. Melting or charring of any part of the sling surface.
- d. Snags, punctures, tears, cuts, or weld splatter that expose core yarns.
- e. Broken or damaged core yarns.
- f. Fittings that are pitted, corroded, cracked, gouged, broken, or distorted.

**18.10.5 Repairs.** Do not make temporary repairs to either roundslings or fittings. Do not repair load-bearing yarns or fittings. Allow only a roundsling manufacturer or qualified person to repair protective covers. When repaired, the roundsling must be marked and proof tested to twice the rated vertical load before it is returned to service.

## 18.11 Wire Mesh Slings and Synthetic Rope Slings

If either wire mesh slings or synthetic rope slings are selected for special use, consult with the appropriate section of ANSI B30.9.

## 18.12 Requirements for Shackles and Other Rigging Hardware

### 18.12.1 Shackles

**a. Safe Working Load.** Load rating will be in accordance with the shackle manufacturer. The design factor for shackles up to and including 150 ton-rated load will be a minimum of 5. The design factor for shackles over 150 ton-rated load shall be a minimum of 4.

**b. Hoisting.** Shackles used for hoisting must be made of forged alloy steel and must be of the screw pin or bolt type.

**c. Shackles Body and Pin Identification.** Each shackle body will have forged, cast, or die stamped markings by the manufacturer to show the name or trademark of the manufacturer, the rated load, and the size. Shackle pins will be similarly marked and show the manufacturer, grade, material type, or load rating.

**d. Inspections.** Conduct a preuse and postuse inspection of the rigging hardware and document the periodic/annual inspection.

**e. Removal from Service.** Immediately remove shackles from service if any of the following conditions are present:

- Shackles are bent, distorted, or worn in the crown or pin by more than 10 percent of their original diameter
- Other conditions exist such as welding damage or arc strike, pitting or corrosion, or excessive thread damage

**18.12.2 Rings, Links, and Swivels.** Hardware items, including rings, links, and swivels, must be made of forged alloy steel of weldless construction and have a minimum design factor of 5. Follow the manufacturer's safe working loads.

**a. Identification.** Each hardware item will have forged, cast, or die stamped markings by the manufacturer to show the name or trademark of the manufacturer, the grade, rated load, or size.

**b. Inspections.** Conduct a preuse and postuse inspection of the rigging hardware and document the periodic/annual inspection.

**c. Removal from Service.** Immediately remove rigging hardware from service if any of the following conditions are present:

- Missing or illegible identification

- Indications of welding damage or arc strike
- Excessive pitting or corrosion
- Bent, twisted, distorted, stretched, elongated, or cracked load-bearing components
- Excessive nicks or gouges
- A 10-percent reduction of the original dimension at any point
- Inability of swivels to freely rotate when not loaded
- Other visible damage

### **18.12.3 Eyebolts, Eye Nuts, Turnbuckles, and Swivel Hoist Rings.**

This hardware used for hoisting must be designed with a minimum safety factor of 5. Load rating will be in accordance with the hardware manufacturer's specifications. If found defective, the rigging hardware will not be repaired; it will be removed from service.

**a. Identification.** Each hardware item will be marked to show the name or trademark of the manufacturer, size or rated load, grade for alloy eyebolts, and torque value for swivel hoist rings.

**b. Inspections.** Inspect the rigging hardware before each use and document the periodic/annual inspection.

**c. Removal from Service.** Immediately remove eyebolts, eye nuts, turnbuckles, and swivel hoist rings from service if any of the following conditions are present:

- Missing or illegible identification
- Indication of heat damage, including weld splatter or arc strikes
- Excessive pitting or corrosion
- Bent, twisted, distorted, stretched, elongated, or cracked load-bearing components
- Excessive nicks or gouges
- A 10-percent reduction of the original dimension at any point
- Excessive thread damage or wear
- The inability of swivel hoist rings to freely rotate when not loaded

- Other visible damage

**d. Rigging Practices**

**1. Tapped Hole.** The minimum depth of the tapped hole for screwed eyebolts and swivel hoist rings must be one and one-half times the bolt diameter.

**2. Application of Load.** Apply loads in the plane of the eye of the eyebolt. Do not reeve slings through eyebolts or attach hooks directly to the eyebolt. Use a shackle to distribute the load.