Industrial Rigging Principles and Practices

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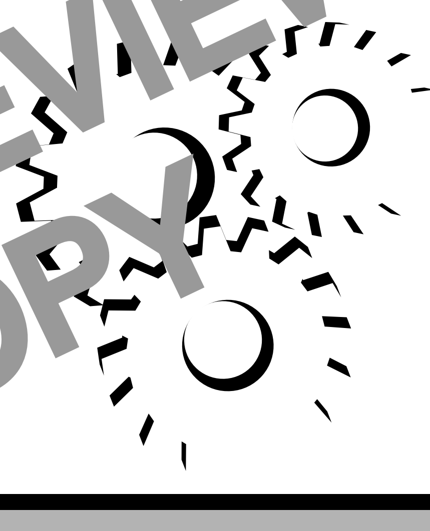
INDUSTRIAL RIGGING PRINCIPLES AND PRACTICES

Lesson One

Introduction to Industrial Rigging



TPC Training Systems

31801

Lesson

1 Introduction to Industrial Rigging

TOPICS

Tools of Industrial Rigging
The Rigging System
Determining the Weight of a Load
Calculating an Allowable Load
Determining Center of Gravity
Vertical and Horizontal Force
Types of Slings
Hooks
Hoist Hooks
Special-Purpose Rigging Hooks
Hook Operating Practices

OBJECTIVES

After studying this Lesson, you should be able to…

- Identify the tools used in rigging and explain the purpose of each.
- Give examples of three methods of calculating the weight of a load.
- Explain center of gravity and its importance in rigging a load.
- Describe four common sling arrangements and the relation between sling angle and horizontal force.
- Name five types of hooks frequently used in rigging and explain the purpose of each.
- Discuss proper hook use and cite four reasons for removing a hook from service.

KEY TECHNICAL TERMS

Breaking strength, or ultimate strength 1.25 the load, expressed in pounds or tons, that will cause a rope to break

Center of gravity 1.28 the point at which a load will balance

Rated load 1.48 the maximum weight recommended for a piece of equipment

ANSI 1.56 American National Standards Institute

ASME 1.56 American Society of Mechanical Engineers

Rigging is basically the preparations involved in moving and placing loads. The specific procedures and tools vary with the type of job. Rigging is used in construction, transportation, and warehousing. It is common in port facilities, utilities, and industry.

The materials to be moved range from small parts in industrial maintenance operations to very heavy loads in construction, transportation, and powerhouse operations. Such applications may require cranes with capacities as great as 600 tons.

This Unit is specifically directed to rigging in industrial plants and operations. Rigging for movement of material may occur indoors or outdoors in remote areas or in confined areas where other workers are present. This Lesson and later Lessons in this Unit will cover the knowledge, tools, and procedures necessary for handling and moving industrial loads.

Tools of Industrial Rigging

1.01 The tools commonly used in industrial rigging include:

- hoists
- slings
- special lifting devices.

1.02 *Hoists* are lifting units or mechanisms. A crane is a piece of equipment that incorporates a hoist. It is used to lift and transport a load some distance and then set it down again. Cranes are also referred to as *hoisting equipment*.

1.03 The terms hoist and crane cover many different forms of equipment. This equipment includes manual and powered devices, underhung and toprunning cranes, monorails, and various types of jib cranes. Each type of hoisting equipment is unique and performs differently in use. You must know what to expect from each of these tools and take appropriate precautions to ensure that dangerous situations do not develop.

1.04 The main purpose of *slings* and *special lifting devices* is to suspend a load from the hoist. Slings are commonly made of wire rope or welded link chain, but can also be constructed from fiber rope, synthetic webbing or metal mesh. Most slings are assembled by sling manufacturers, although they can be assembled by the user at the job site. In job-site assembly, the rigger must give careful consideration to the components used, assembly methods, and the testing required by safety standards and codes.

1.05 Special lifting devices are pieces of equipment especially designed to handle specific types of loads. They are usually made to hang from the hook of a hoist. Examples of lifting devices include mechanical grabs, friction grabs, vacuum lifters, magnets, and special clamps or lifting holders.

1.06 Loads for which these devices are designed include sheet metal, steel coils, paper rolls, glass, and buckets of molten metal. Lifting devices are also used in repetitive applications such as machine-tool loading and assembly operations.

The Rigging System

1.07 A load, a sling, and hoisting equipment are three separate items. But when the weight of the load is transferred from its stationary position to the sling and hoist, all three items become a single, complex rigging system. The rigger, as the designer and operator of the system, is also a part of it.

1.08 The rigger must apply his or her intelligence, common sense, and experience in anticipating what will happen when the load is moved. This thought process must take place before the work is started. In order to ensure the design of a safe and efficient system, the rigger must answer such questions as:

- What is to be done with the load?
- What tools are needed to perform the desired task?

Table 1-1. Nominal weight per linear foot for steel and brass rods

Rod diameter (in.)	Weight per linear foot (lb)	
	Steel	Brass
1/4	0.167	0.181
1/2	0.667	0.724
3/4	1.50	1.63
1	2.67	2.89
1 1/4	4.17	4.52
1 1/2	6.01	6.51
1 3/4	8.18	8.86
2	10.68	11.57
2 1/4	13.52	14.65
2 1/2	16.69	18.10
2 3/4	20.20	21.90
3	24.03	26.04

- Do the tools have the capacity to handle the loads and forces involved?
- How can the hookup be made?
- What will happen when the load is first moved?
- What will be the travel path of the load to reach the desired location?
- How will the load be set down at the desired location?
- What other factors are involved (weather, electrical wires, sloping grades, visibility)?
- Are additional personnel needed to control the load safely during the process?

1.09 Engineering training is not required of the rigger. However, you must understand and use certain mechanical engineering basics when planning a rigging system. These fundamentals include:

- determining the weight of a load
- locating the center of gravity of a load
- distinguishing the force components (horizontal and vertical) at work in a diagonal force.

This last calculation is necessary when the leg of a sling is attached to a load at some angle other than 90° to the horizontal.

1.10 You must also determine the limitations of every component of the rigging system. The entire system can be no stronger than the weakest component.

Determining the Weight of a Load

1.11 Try to determine the load weight from shipping papers, manufacturer's information attached to the load, catalogs, or blueprints. Be sure the weight has not changed since the information was recorded. If the weight is for an empty container, for example, check to make sure it is still empty.

1.12 If you cannot find the weight from any of these sources, then check tables that give the weight per foot for standard materials. A table of this type is shown in Table 1-1. It lists weight per linear foot for steel and brass rods of various diameters. More detailed tables can be obtained from handbooks and manufacturers.

1.13 As an example of how these tables are used, determine the weight of a load consisting of 150 steel rods, 20 ft long and 3/4 in. in diameter. Use Table 1-1 and the following equation:

$$W = w/ft \times L \times Q$$

where

W = weight

w/ft = weight per foot (lb)

L = length (ft)

Q = quantity.

1.14 If you substitute the values in the example, the equation reads

$$W = 1.50 \times 20 \times 150$$

$$= 4500 \text{ lb.}$$

Tables are also available for structural shapes such as beams, channels, and angles.

1.15 In addition, the designation of some structural shapes includes the weight per linear foot. A steel I beam of American Standard shape and 15 in. deep, for instance, is designated S15 × 42.9. The 42.9 is the weight in pounds per foot of length.

1.16 When you use a designation like this to determine the weight of a load (usually a single unit), the Q in the formula given above is unnecessary. For example, determine the weight of a 50 ft, S15 × 42.9 beam that is to be moved.

$$W = w/ft \times L$$

$$= 42.9 \times 50$$

$$= 2145 \text{ lb.}$$

1.17 If you cannot determine the weight by one of these methods, you must calculate it by using the volume of the object and the weight per unit volume for the material of the object. Equations useful in calculating area and volume are shown in Fig. 1-1. Table 1-2 on the following page lists weights of common materials.

1.18 In equations such as

Weight = volume × weight per unit volume

Volume = area of base of object × height,

the figures used for area, volume, and weight per unit volume must be in the same units. In other words, if volume

Fig. 1-1. Formulas for area and volume of plane and solid figures

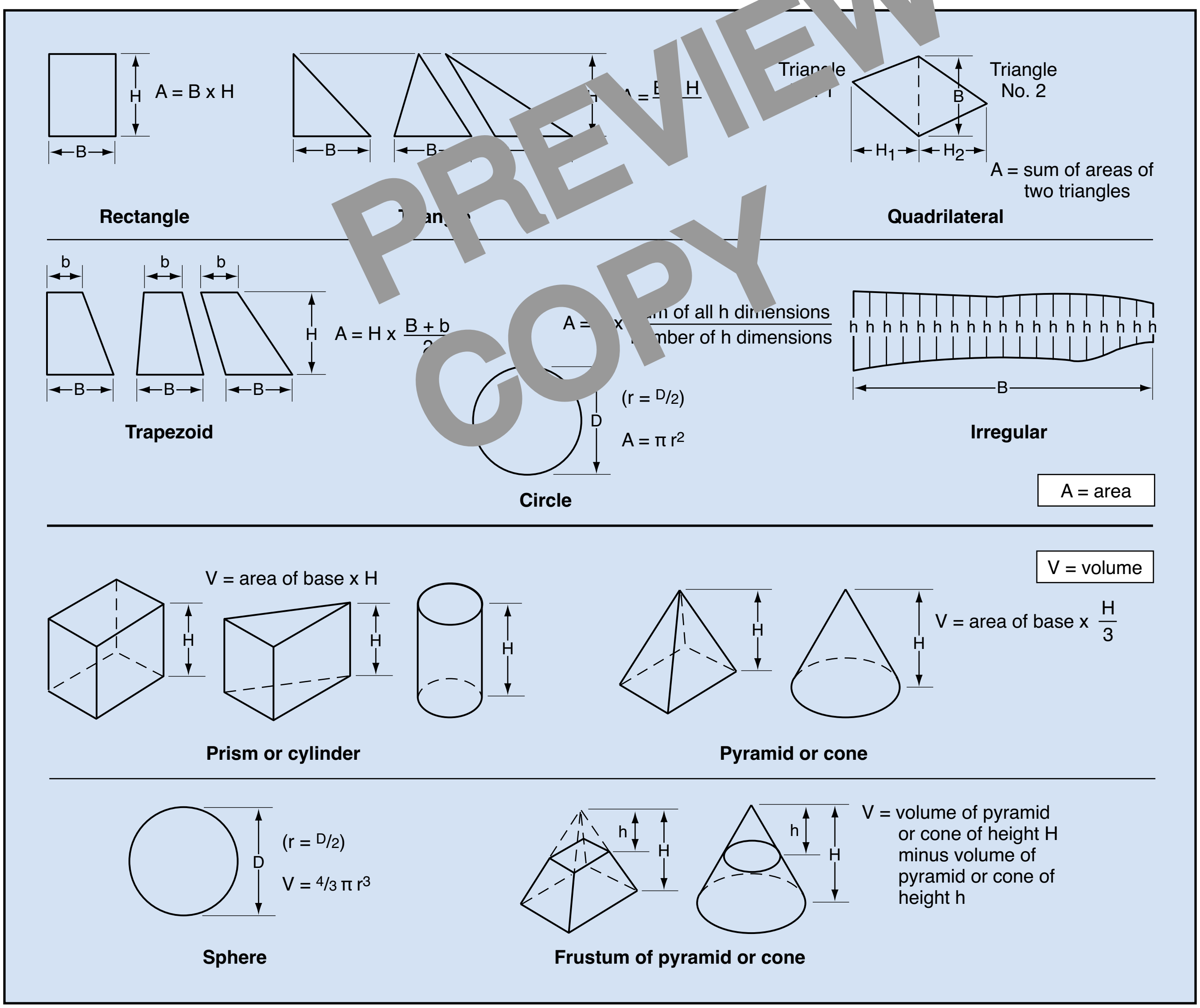


Table 1-2. Weights of common materials

Name of metal	Weight (lb/ft^3)
Aluminum	166
Antimony	418
Bismuth	613
Brass, cast	504
Brass, rolled	523
Copper, cast	550
Copper, rolled	555
Gold, 24-carat	1204
Iron, cast	450
Iron, wrought	480
Lead, commercial	712
Mercury, 60°F	846
Silver	655
Steel	490
Tin, cast	458
Zinc	437

Name of wood	Weight (lb/ft^3)
Ash	35
Beech	37
Birch	40
Cedar	22
Cherry	30
Chestnut	26
Cork	15
Cypress	[illegible]
Ebony	[illegible]
Elm	3[illegible]
Fir, bals[illegible]	22
Hem[illegible]k	[illegible]

Name of material	Weight (lb/ft^3)
Bluestone	160
Brick, pressed	150
Brick, common	125
Cement, Portland (packed)	100 to 120
Cement, Portland (loose)	70 to 90
Cement, slag (packed)	80 to 100
Cement, slag (loose)	55 to 75
Chalk	156
Charcoal	15 to 34
Cinder concrete	110
Clay, ordinary	120 to 150
Coal, hard, solid	93.5
Coal, hard, broken	54
Coal, soft, solid	84
Coal, soft, broken	54
Coke, loose	23 to 32
Concrete, or stone	140 to 155
Earth, rammed	9[illegible]o 100
Granite	16[illegible]o 170
Gravel	[illegible]o 125
Lime, quick (gr[illegible]loo[illegible])	[illegible]3
Limeston[illegible]	[illegible]0
Marb[illegible]	164
Plast[illegible] of [illegible]ris [illegible]ast)	80
[illegible]and	90 to 106
[illegible]ds[illegible]ne	151
Sha[illegible]	162
Slate	160 to 180
[illegible]erra-cotta	110
Trap rock	170

Note: 1[illegible] = 144 in[illegible]   1 ft^3 = 1728 in^3

is expressed in cubic feet (ft^3), weight per unit volume must be lb/ft^3. Likewise, if volume is expressed in cubic inches (in^3), weight per unit volume must be lb/in^3.

1.19 The weights listed in Table 1-2 are in lb/ft^3. To find the weight in lb/in^3, divide these numbers by 1728. For example, the weight of steel is given as 490 lb/ft^3. Dividing 490 by 1728 converts this weight to 0.284 lb/in^3.

1.20 You can find the volume of complex objects by first mentally breaking the object into the simple shapes shown in Fig. 1-1. By determining the volumes of these simple shapes and adding them together (or otherwise modifying them as needed), you can estimate the volume of the entire object. If the object is made of two or more materials, determine the volume and weight of each material and then total the weights.

1.21 For example, calculate the weight of a steel tube rolled and fabricated from steel plate 1 in. thick, as shown in Fig. 1-2. First, determine what the volume of the tube would be if the tube were solid (using the outside dimensions):

$$\text{Volume} = \text{area of base} \times \text{height}$$

$$\text{Volume} = \pi r^2 \times H$$

$$\text{Volume} = 3.14159 \times (24 \text{ in.})^2 \times 48 \text{ in.}$$

$$\text{Volume} = 86{,}859 \text{ in}^3.$$

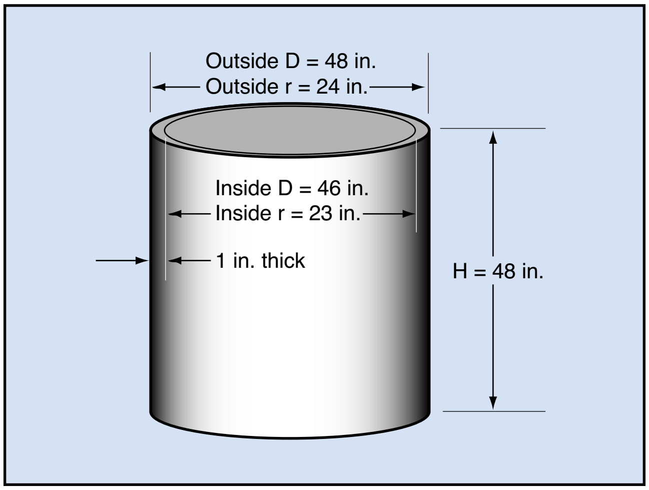
1.22 Next, determine the volume of space inside the tube (using the inside dimensions):

$$V = \pi r^2 \times H$$

$$V = 3.14159 \times (23 \text{ in.})^2 \times 48 \text{ in.}$$

$$V = 79{,}771 \text{ in}^3.$$

Fig. 1-2. Steel tube



1.23 Then calculate the volume of the tube itself like this:

$$V = 86{,}859 \text{ in}^3 - 79{,}771 \text{ in}^3$$

$$V = 7088 \text{ in}^3.$$

Finally, proceed to find the weight:

$$W = 7088 \text{ in}^3 \times 0.284 \text{ pounds per cubic in.}$$

W= 20131b.

Calculating an Allowable Load

1.24 Once you have found the weight of the load, some further calculations will indicate whether or not it is within the limits of an allowable load. The basic steps in this process involve the following data:

- the breaking strength of the rope
- the design factor.

1.25 *Breaking strength*, also called *ultimate strength*, is the load that will cause the rope to break. This information can be found in standard tables in rigging handbooks, listed according to the diameter and kind of rope. Handbook tables will also give you the design factor, or safety factor. Different design factors are established for different rope applications—slings, hoisting tackle, etc. Although requirements may vary with circumstances, a generally accepted design factor for wire-rope slings is 5.

1.26 You find the load limit by dividing the breaking strength of the rope by the design factor. For example, suppose the table indicates that the breaking strength of the rope you are using is 27,000 lb. Dividing this figure by the design factor of 5 gives you 5400 lb as a maximum allowable load.

1.27 In that case, the weight of the steel tube you calculated in the earlier example (2025 lb) would be well within the limits of an allowable load. As mentioned in paragraph 1.23, this is the basic procedure. Other factors you must consider in calculating an allowable load will be discussed in later Lessons.

The Programmed Exercises on the next page will tell you how well you understand the material you have just read. Before starting the exercises, remove the REVEAL KEY from the back of your Book. Read the instructions printed on the Reveal Key. Follow these instructions as you work through the Programmed Exercises.

1-1. The main purpose of slings and lifting devices is to suspend a load from the ________.	1-1. HOIST Ref: 1.04
1-2. A load, a sling, and hoisting equipment are three components of a(n) ________.	1-2. RIGGING SYSTEM Ref: 1.07
1-3. In the load weight equation (W=w/ft x L x Q), Q stands for ________.	1-3. QUANTITY Ref: 1.13
1-4. The weight of a 20 ft, S15 x 42.9 beam is ________.	1-4. 858 lb Ref: 1.16
1-5. Another way to calculate the weight of a load is to find the volume of the object and multiply it by the ________.	1-5. WEIGHT PER UNIT VOLUME Ref: 1.17, 1.18
1-6. If you are using the method just mentioned, and the volume of the object is expressed in in^3, the weight per unit volume must be expressed in ________.	1-6. LB/IN^3 Ref: 1.18
1-7. The generally accepted design factor for wire-rope slings is ________.	1.7 5 Ref: 1.25
1-8. To find the maximum allowable load for a wire rope, you divide the breaking strength of the rope by the ________.	1-8. DESIGN FACTOR or SAFETY FACTOR Ref: 1.26

Determining Center of Gravity

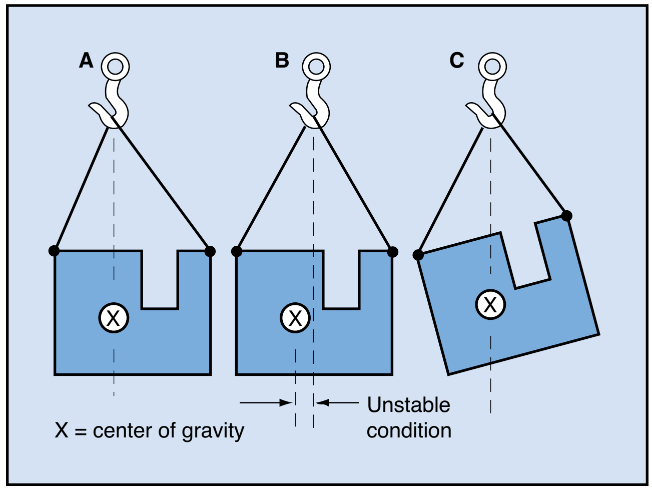
1.28 The *center of gravity* of a load is the point at which the load will balance. The whole weight of the load can be considered to be concentrated at this balance point. When suspended from a point, the load tends to move so that the center of gravity is directly below the point of support.

1.29 In rigging, it is essential that the load to be lifted is stable. A stable load is balanced about its center of gravity. An unstable load has a tendency to tip or topple, creating a hazardous situation for both personnel and equipment in the immediate area.

1.30 Before lifting a load, make sure its center of gravity is located directly below the hoisting hook, as shown in Fig. 1-3A. If it is not directly below the hoisting hook when a lift is attempted (Fig. 1-3B), the load will be unstable. If the sling is free to slide across the hoist hook, the center of gravity will shift directly below the hook and the load will tip, as shown in Fig. 1-3C. If two slings are used, so that sling length cannot change, one sling will assume a greater share of the load than the other.

1.31 The sling must *not* be attached to the load at a point lower than the load's center of gravity. An example of acceptable sling attachment points is shown in Fig. 1-4A. If the center of gravity of the load is above the sling attachment points, as shown in Fig. 1-4B, the load will be unstable and will topple when it is lifted.

Fig. 1-3. Center of gravity and the hoist hook



1.32 The only exception to this rule occurs when you must lift loads on skids, pallets, or bases. In that case, make sure the apex of the sling, where the sling branches meet, is above the center of gravity (Fig. 1-5A). If the apex of the sling is below the center of gravity, as shown in Fig. 1-5B, this unstable condition could cause the load to topple.

1.33 The center of gravity may be marked on a load by the manufacturer or located in catalog information or blueprints. Some objects have lifting lugs, placed by the manufacturer and based on the center of gravity of the object. If you cannot locate the center of gravity by one of these means, you should attempt to calculate it or estimate it.

Fig. 1-4. Sling attachment points

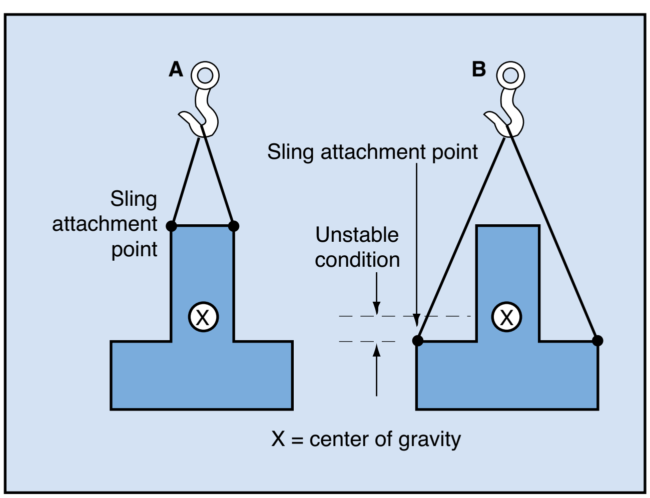


Fig. 1-5. Sling apex and center of gravity

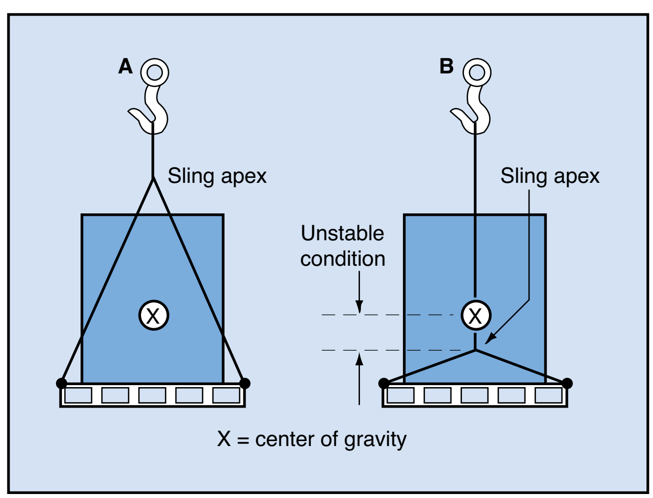
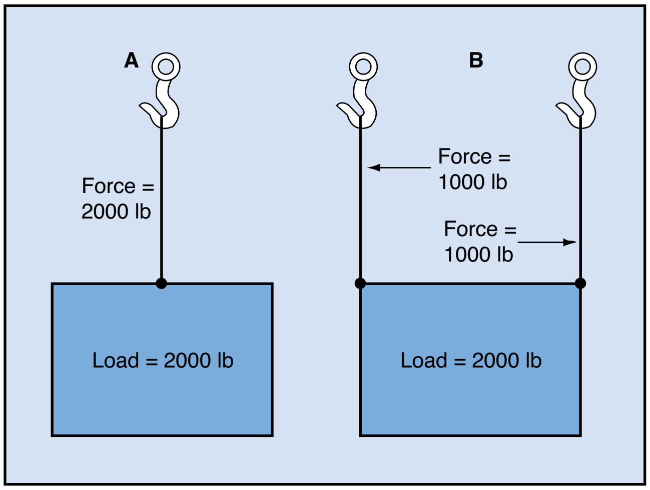


Fig. 1-6. Vertical force on slings

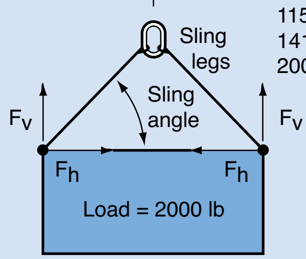


1.34 There is no simple way to find the center of gravity of a three-dimensional object. If the object is complex in shape and is made of more than one material, lengthy calculations would be required to find the center of gravity. In many instances, you will have to make an educated guess as to the location of the center of gravity and then correct by trial and error before making the lift.

1.35 Connect the hoisting hook and sling attachments based on an estimate of the object's center of gravity. Take up the slack in the hoist and sling lines and lift the load just enough to check its stability. If the load is stable, continue lifting. If the load is unstable, lower the load and correct the rigging. Move the lift point closer to the end of the load that dips. Repeat this practice until the load is stable.

Table 1-3. Sling leg force at different sling angles

Sling angle	Sling leg force (pounds each leg)
90°	1000
75°	1035
60°	1155
45°	1414
30°	2000



Vertical and Horizontal Force

1.36 The force acting on a single sling leg attached vertically to a load is equal to the weight of the load, as shown in Fig. 1-6A. If two slings are attached vertically to the load, each one lifts half the load (Fig. 1-6B).

1.37 Very often, however, the sling legs are attached to the load at an angle of less than 90°. Then, as shown in Table 1-3, a horizontal force (Fh) is added to the vertical force (Fv). As a result, the combined forces acting on the sling legs are greater than the weight of the load.

1.38 As indicated in Table 3, the horizontal force increases as the angle (called the *sling angle*) becomes smaller. Note that when the sling angle is 30°, the total force on the two sling legs is twice that of the load. Sling angles of less than 45° are not recommended.

1.39 Horizontal forces exerted by small sling angles have to be reckoned with for another reason. They also act on the load as it is being lifted. These forces can damage or break a load through compression or buckling, as illustrated in Fig. 1-7A. When handling loads that could be damaged by horizontal forces, you will need to use a spreader beam.

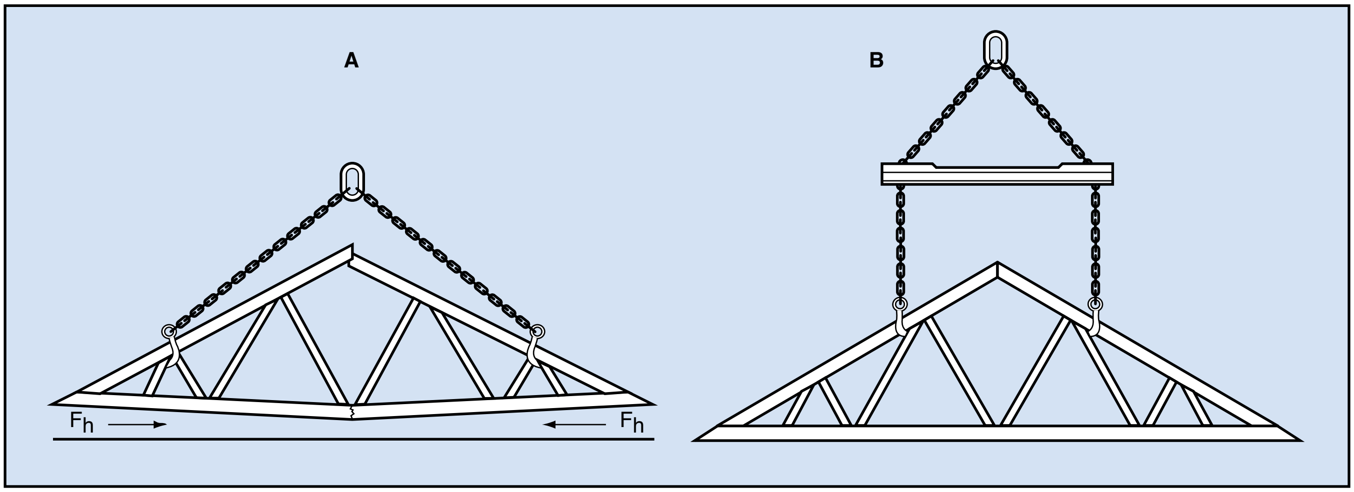
1.40 A typical *spreader beam* is shown in Fig. 1-7B. The horizontal forces caused by the sling angle are absorbed by the spreader beam. The sling legs between the spreader beam and the load are vertical and therefore do not exert horizontal forces on the load.

Types of Slings

1.41 A sling is an assembly used for lifting or pulling loads. The upper end of a lifting sling is connected to a hoisting mechanism, and its lower end supports a load. Sling components include hooks, coupling links, fittings, and sling legs. Most slings used in industrial rigging are obtained from manufacturers or their approved assembly and repair stations.

1.42 You can also assemble slings at the job site if necessary. When you do, however, you must use the recommended components and assembly procedures to ensure the strength of the assembled sling.

Fig. 1-7. A spreader beam eliminates horizontal forces

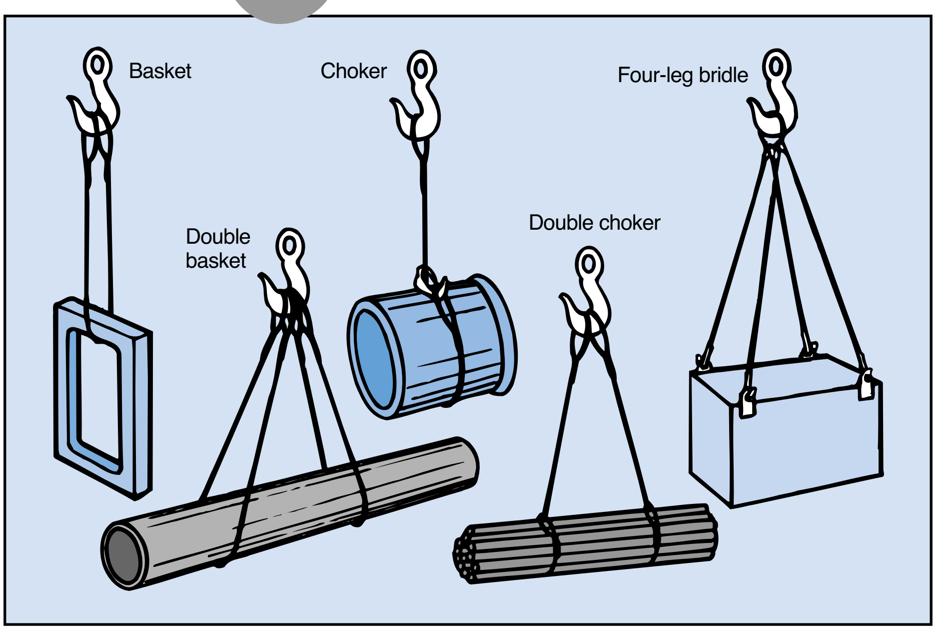


1.43 Basic materials used for endless and multiple-leg slings include wire rope, welded-link chain, natural-fiber rope, synthetic-fiber rope, synthetic webbing, and metal mesh. Each of these materials is affected differently by environmental conditions. Approved operating practices and inspection procedures are essential for continued safety. They are different for each material. These materials and slings made from them will be discussed individually in later Lessons of this Unit.

1.44 There are many different sling arrangements, or *hitches*. A few examples are shown in Fig. 1-8. The *basket* hitch is looped around the load, which must then be balanced to prevent tipping. The *double basket* hitch is often used to lift plates or rods. With this type of hitch, you must be sure the load is properly centered. The legs must be far enough apart to balance the load. However, they must not be so far apart that horizontal forces cause them to shift toward the center of the load.

1.45 The *choker* hitch is popular because of the clamping effect it has on the load. The *double choker* is suited for handling pipe, bars, and rods.

Fig. 1-8. Various sling arrangements



Balancing requirements for the choker hitch are similar to those for the basket hitch.

Hooks

1.46 Hooks are constantly used in rigging. They are a component of practically all hoists, cranes, and slings. Hooks are usually forged from plain carbon or alloy steel and then heat-treated for strength.

1.47 Other materials and manufacturing methods are used to make hooks for special applications. Permanent deformation in the form of straightening of the hook should be noticeable before a fracture occurs in some other part of the hook.

1.48 Attachments should never be field welded to a hook (that is, welded at the job site). Heat should not be applied in an attempt to reshape a hook. Heat applied to a hook in this manner can reduce the strength of the hook. This reduction in strength can result in hook failure at loads lower than the rated load of the hook. The *rated load* is the weight recommended by the manufacturer as the maximum allowable load for a piece of equipment. If handles or other attachments are required on a hook, they should be obtained from the hook or equipment manufacturer.

Hoist Hooks

1.49 Hoist hooks support a load in a direct pull, with the load supported in the *saddle*, or *bowl*, of the hook. Hooks of this type are used on overhead hoists and cranes. A typical hoist hook, with parts of the hook identified, is shown in Fig. 1-9A.

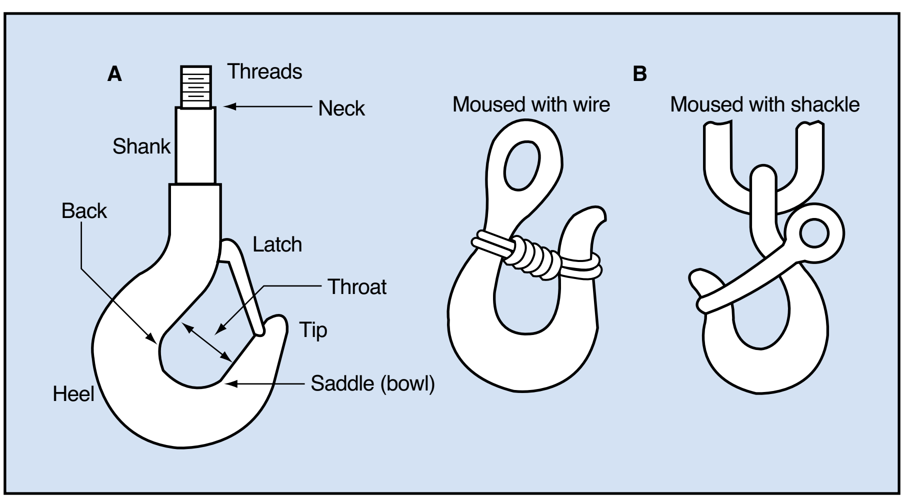
1.50 The rated load of hoist hooks is specified with the assumption that the load is applied at the hook saddle. Loads applied between the saddle and tip can cause hook failure at loads below the rated capacity. The load should never be applied at the hook tip.

1.51 Hoist and crane hooks should be equipped with latches to close the throat opening of the hook. This precaution should be omitted only if the use of a latch is impractical or creates a hazardous situation for the operator.

1.52 When a load is set on the ground, the sudden release from tension may cause the sling legs to jump or slip out of the hook opening. The purpose of the latch is to retain the sling in the hook under such slack conditions. It is important to remember, however, that latches are designed only to keep the sling eyes in the hook and are not intended to support the load.

1.53 If a hoist hook does not have a latch, and you wish to close the throat opening, you can mouse the hook at the job site. *Mousing* is the process of closing the hook opening by use of a rope, wire, or shackle, as shown in Fig. 1-9B. When mousing a hook with wire, wrap the wire around the back and tip several times. Then wind the wire around the wraps several times before securely tying the wire ends.

Fig. 1-9. Typical hoist hook and mousing methods



Special-Purpose Rigging Hooks

1.54 Hooks such as those shown in Fig. 1-10 are designed for specific rigging purposes. The *foundry* hook has a wide, deep throat to fit handles on molds and castings. The *grab* hook has a narrow throat and is used to hold a length of chain by engaging one link flat in the hook between two other chain links. The *sorting* hook has a point designed to fit into holes. Some choker slings are fitted with a sliding choker hook that engages the eye of the sling, as shown in Fig. 1-8 on page 13.

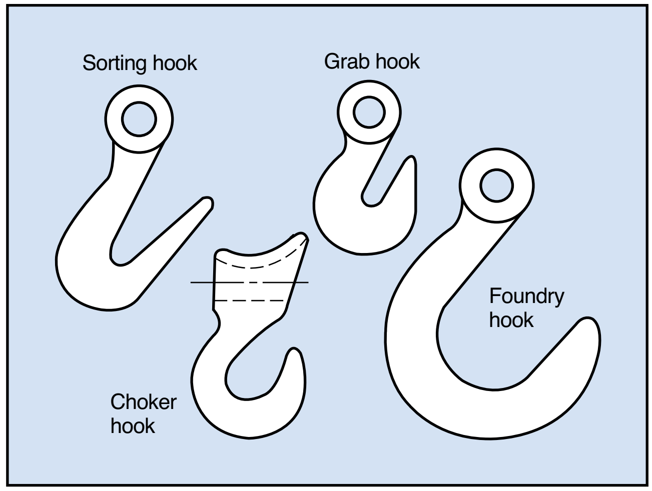
Hook Operating Practices

1.55 Some safe operating practices that should be observed when using hooks are:

- Hooks of different types should be used only for their intended purpose.
- The weight of the load to be lifted should not exceed the rated load of the hook or of the hoist equipment or sling assembly of which the hook is a component.
- Loads applied to hooks should be centered in the hook saddle—not on the point of the hook.
- Shock loading, such as sudden, jerky lifting of the load, should be avoided.
- If you use a latch or other device to close the throat of a hook, be careful not to apply the load to the closing device.
- Take care to keep hands, fingers, and body from between the hook and the load.

1.56 Hooks should be inspected frequently and periodically. *Frequent* inspections are visual examinations the operator should make every day before using the equipment. *Periodic* inspections should be conducted at regular intervals by specially designated inspectors. The length of inspection intervals depends upon the type of hook service. Records should be maintained as a basis for continuing evaluation. The inspection requirements for hooks are covered

Fig. 1-10. Special-purpose rigging hooks



in detail in the *ANSI/ASME* publication B30.10, *Safety Standard for Hooks*.

1.57 The following are some of the reasons for removing a hook from service and replacing it:

- Hook throat has increased by more than 15%.
- Wear exceeds 10% of the original hook section dimension, or there is a bend or twist of more than 10° from the plane of the unbent hook.
- Hook shows cracks, excessive nicks, or gouges. These damages can sometimes be repaired by filing along the hook contour. The hook cannot be reused, however, if the filing reduces any dimension by more than 10% of its original value.
- The portions that form the throat of a grab hook are not parallel.

1.58 Twist or increase in throat opening is often an indication of abuse or overload of the equipment. In such instances, other components of the sling or hoisting mechanism should also be inspected for damage.

1.59 While the above reasons for hook replacement are established guides, some of the figures may vary according to the manufacturer.

1-9. A load's center of gravity is the point at which the load will ________.	1-9. BALANCE Ref: 1.28
1-10. For a stable lift, you must rig a load so that its center of gravity is directly below the ________.	1-10. HOIST HOOK Ref: 1.29, 1.30
1-11. In rigging, sling angles of less than ________° are not recommended.	1-11. 45 Ref: 1.38
1-12. A sling can be assembled by the rigger at the job site. True or False?	1-12. TRUE Ref: 1.42
1-13. The choker hitch is often useful because of the ________ effect it has on the load.	1-13. CLAMPING Ref: 1.45
1-14. A load should be applied to the hook saddle–never to the hook ________.	1-14. TIP Ref: 1.50
1-15. The operator should inspect hooks every ________ before using the equipment.	1-15. DAY Ref: 1.56
1-16. A grab hook should be replaced if the portions that form the throat are not ________.	1-16. PARALLEL Ref: 1.57

Answer the following questions by marking an "X" in the box next to the best answer.

1-1. All of the following are among the tools used in rigging EXCEPT

- ☐ a. hoists
- ☐ b. jacks
- ☐ c. cranes
- ☐ d. slings

1-2. The main purpose of a sling is to

- ☐ a. raise and lower a load
- ☐ b. suspend a load from a hoist
- ☐ c. tie down a load securely
- ☐ d. suspend a hoist hook from a crane

1-3. What is the weight of a load of 25 steel rods, 30 ft long, each weighing 1.5 lb/ft?

- ☐ a. 450 lb
- ☐ b. 1025 lb
- ☐ c. 1125 lb
- ☐ d. 4500 lb

1-4. To find the weight of a 40 ft steel I beam designated S15x42.9, you would use the equation

- ☐ a. W = w/ft × L
- ☐ b. W = area of base × height
- ☐ c. W = w/ft x L × Q
- ☐ d. W = volume × weight per unit volume

1-5. Before lifting a load, you should make sure its center of gravity is

- ☐ a. above the apex of the sling
- ☐ b. located exactly through calculation
- ☐ c. directly below the hoisting hook
- ☐ d. above the sling attachment points

1-6. The total horizontal and vertical forces acting on two sling legs

- ☐ a. decrease as the sling angle decreases
- ☐ b. must equal the weight of the load
- ☐ c. increase as the sling angle decreases
- ☐ d. must be less than half the weight of the load

1-7. To avoid damaging a load that would buckle under the horizontal force exerted by an ordinary sling attachment, you would use

- ☐ a. chain slings
- ☐ b. a smaller sling angle
- ☐ c. coupling links
- ☐ d. a spreader beam

1-8. In which of the following hitches must the sling legs be far enough apart to balance the load but not so far apart that they shift toward the center?

- ☐ a. Double basket and double choker
- ☐ b. Basket and bridle
- ☐ c. Double choker and double bridle
- ☐ d. Double bridle and choker

1-9. One special-purpose hook has a point designed to fit into holes. Which is it?

- ☐ a. Foundry hook
- ☐ b. Grab hook
- ☐ c. Sorting hook
- ☐ d. Choker hook

1-10. Which of the following is a reason for removing a hook from service?

- ☐ a. Hook is twisted 12% out of line
- ☐ b. Sorting hook has no latch
- ☐ c. Hook throat has increased by 5%
- ☐ d. Hook has been moused with wire

SUMMARY

Rigging consists of the preparations involved in lifting and moving loads. The tools used in rigging include hoists, cranes, slings, and special lifting devices. To ensure a safe and efficient rigging system, riggers must anticipate what will happen when the load is moved.

They must know how to use tables, formulas, and other aids to calculate the weight of the load and determine if that weight is within the capacity of the rigging system. The entire system can be no stronger than its weakest element. They must learn to locate, or estimate the location of, the load's center of gravity to make sure the load is stable when lifted. Another factor that must be taken into account is the horizontal force (as well as the vertical force) exerted on the sling and on the load it lifts.

Sling legs and the hardware included in a sling assembly must be inspected frequently. Such inspections are also critical for the many types of hooks—both hoist and sling hooks—that are used in rigging.

Answers to Self-Check Quiz

1-1. b. Jacks. Ref: 1.01

1-2. b. Suspend a load from a hoist. Ref: 1.04

1-3. c. 1125 lb. Ref: 1.13

1-4. a. $W = w/ft \times L$. Ref: 1.15,1.16

1-5. c. Directly below the hoisting hook. Ref: 1.30

1-6. c. Increase as the sling angle decreases. Ref: 1.38

1-7. d. A spreader beam. Ref: 1.39, 1.40

1-8. a. Double basket and double choker. Ref: 1.44, 1.45

1-9. c. Sorting hook. Ref: 1.54

1-10. a. Hook is twisted 12% out of line. Ref: 1.57

Contributions from the following sources are appreciated:

Figure 1-7. ACCO Babcock Inc., American Chain Division
Figure 1-9. Whiting Corporation
Figure 1-10. The American Society of Mechanical Engineers, ANSI/ASME b30.10-Safety Standard for Hooks-1982