



TRINIDAD
DESIGN &
MANUFACTURING

TDM In-House Overhead Cranes & Rigging Course

Safe Operations Training

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1 Introduction

The objective of this course is to provide the employees of TDM with the necessary information to enable them to safely use overhead cranes & rigging hardware in their work place and to prevent personal injuries and property damage.

OVERVIEW

The crane is one of the most essential pieces of equipment used in the handling and transportation of goods and material in the manufacturing industry, whether it is a *fixed* or *mobile* type of crane.

Accident statistics verify conclusively that a high percentage of industrial accidents occur during crane operation.

Everyone involved in the movement of a load must be fully aware of the potential consequences of poor lift planning and execution.

The rigger who hooks up the load, the engineer (if applicable), the supervisor, and the person responsible for the load weight calculation and its final position, must know the crane capacity and limitations.

However, the ultimate responsibility lies with the crane operator to ensure the lift is made safely, the crane is undamaged, and there are no injuries to any personnel

In order to operate a crane safely and effectively, the crane operator must understand all aspects of the machine, including:

- Crane controls location and movement.
- Crane movements.
- Crane capacities.
- How to read and use load charts and related information.
- Operation speeds.
- Crane signals, both visual and audible.

The crane operator must also have a basic knowledge of crane inspections to be able to identify any defects in the crane structures, hoisting assembly, or the rigging.

All TDM workers who are required to operate an overhead crane must complete the in-house overhead crane and rigging course. Upon successfully completion of this course the worker will be issued a TDM Overhead crane and rigging ticket.

This course does not make a worker competent. Before he/she is permitted to operate an overhead crane unsupervised, the worker must demonstrate that he/she has achieved competency to his/her supervisor. The supervisor must document this achievement on the QF-32 training form. A copy of this form is added to the worker's file by the HSE and HR. Dept.'s.



SAFETY - YOUR RESPONSIBILITIES

Workers have a legal duty to work safely, and follow health and safety rules set out by the employer and in workplace safety legislation.

The general duties for workers are more formally set out under the OH & S Act, as follows:

2(2) Every worker shall, while engaged in an occupation,

- a) take reasonable care to protect the health and safety of the worker and of other workers present while the worker is working, and**
- b) co-operate with the worker's employer for the purposes of protecting the health and safety of**
 - i) the worker,**
 - ii) other workers engaged in the work of the employer, and**
 - iii) other workers not engaged in the work of that employer but present at the work site at which that work is being carried out.**

This means that each worker has to take reasonable care to work safely on their own and with other workers present, and to cooperate with their employer when it comes to workplace health and safety.

SAFETY – TDM'S RESPONSIBILITIES

As a worker, you should not only know your own responsibilities for workplace safety, but also those of your employer. For example, employers have many responsibilities relating to Part 2 of the Code, regarding hazard assessment, elimination and control. Workers need to work with employers by participating in hazard assessment processes - this is in everyone's best interest.

Employers are required by law to make sure that workers work safely. An employer must also ensure that workers are trained and have sufficient skills to perform their work safely, and that they understand their duty to work safely on their own and with others, as described in Section 15 (Safety Training) of the regulations:

- 15(1) *An employer must ensure that a worker is trained in the safe operation of the equipment the worker is required to operate.*
- (2) *An employer must ensure that the training referred to in subsection (1) includes the following:*
 - a. *the selection of the appropriate equipment;*
 - b. *the limitations of the equipment;*
 - c. *an operator's pre-use inspection;*
 - d. *the use of the equipment;*
 - e. *the operator skills required by the manufacturer's specifications for the equipment;*
 - f. *the basic mechanical and maintenance requirements of the equipment;*
 - g. *loading and unloading the equipment if doing so is a job requirement;*
 - h. *the hazards specific to the operation of the equipment at the work site.*
- (3) *If a worker may be exposed to a harmful substance at a work site, an employer must*
 - a. *establish procedures that minimize the worker's exposure to the harmful substance, and*
 - b. *ensure that a worker who may be exposed to the harmful substance*
 - i. *is trained in the procedures,*
 - ii. *applies the training, and*
 - iii. *is informed of the health hazards associated with exposure to the harmful substance.*
- (4) *A worker must participate in the training provided by an employer.*
- (5) *A worker must apply the training referred to in subsections (1) and (3).*

Clearly, all parties have a stake in making the workplace as safe as possible. This course provides material to help you to gain additional knowledge and to be in a good position to contribute to health and safety objectives in the workplace.

Any worker who contravenes or undermines TDM's safety policies, safe work practices or legislative requirements will be subject to disciplinary action.

At no time will a worker put another worker's health and safety at risk. Any deliberate wilful damage to company property will not be tolerated. Always follow safe operating practices, procedures and the manufacturer's operating instructions for the equipment you are using.

Any injuries, Incidents, Equipment failures, Near misses or property damage must be reported to your supervisor and the HSE dept immediately.

When in doubt, always check with your supervisor

2 Legislation



OH&S ACT

OBLIGATIONS OF EMPLOYERS, WORKERS, ETC.

2(1)

Every employer shall ensure, as far as it is reasonably practicable for the employer to do so,

- (a) the health and safety of
 - (i) workers engaged in the work of that employer, and
 - (ii) those workers not engaged in the work of that employer but present at the work site at which that work is being carried out, and
- (b) that the workers engaged in the work of that employer are aware of their responsibilities and duties under this Act, the regulations and the adopted code.

2(2)

Every worker shall, while engaged in an occupation,

- (a) take reasonable care to protect the health and safety of the worker and of other workers present while the worker is working, and
- (b) co-operate with the worker's employer for the purposes of protecting the health and safety of
 - (i) the worker,
 - (ii) other workers engaged in the work of the employer, and
 - (iii) other workers not engaged in the work of that employer but present at the work site at which that work is being carried out.

2(3)

Every supplier shall ensure, as far as it is reasonably practicable for the supplier to do so, that any tool, appliance or equipment that the supplier supplies is in safe operating condition.

2(4)

Every supplier shall ensure that any tool, appliance, equipment, designated substance or hazardous material that the supplier supplies complies with this Act, the regulations and the adopted code.

2(5)

Every contractor who directs the activities of an employer involved in work at a work site shall ensure, as far as it is reasonably practicable to do so, that the employer complies with this Act, the regulations and the adopted code in respect of that work site.

EXISTENCE OF IMMINENT DANGER

35(1)

No worker shall

- (a) carry out any work if, on reasonable and probable grounds, the worker believes that there exists an imminent danger to the health or safety of that worker,
- (b) carry out any work if, on reasonable and probable grounds, the worker believes that it will cause to exist an imminent danger to the health or safety of that worker or another worker present at the work site, or
- (c) operate any tool, appliance or equipment if, on reasonable and probable grounds, the worker believes that it will cause to exist an imminent danger to the health or safety of that worker or another worker present at the work site.

35(2)

In this section, “imminent danger” means in relation to any occupation

- (a) a danger that is not normal for that occupation, or
- (b) a danger under which a person engaged in that occupation would not normally carry out the person’s work.

35(3)

A worker who

- (a) refuses to carry out work, or
- (b) refuses to operate a tool, appliance or equipment

pursuant to subsection (1) shall, as soon as practicable, notify the worker’s employer at the work site of the worker’s refusal and the reason for the worker’s refusal.

35(4)

On being notified under subsection (3), the employer shall

- (a) investigate and take action to eliminate the imminent danger,
- (b) ensure that no worker is assigned to use or operate the tool, appliance or equipment or to perform the work for which a worker has made a notification under subsection (3), unless
 - (i) the worker to be so assigned is not exposed to imminent danger, or
 - (ii) the imminent danger has been eliminated,
- (c) prepare a written record of the worker’s notification, the investigation and action taken, and
- (d) give the worker who gave the notification a copy of the record described in clause (c).

35(5)

The employer may require a worker who has given notification under subsection (3) to remain at the work site and may assign the worker temporarily to other work assignments that the worker is reasonably capable of performing.

35(6)

A temporary assignment under subsection (5), if there is no loss in pay, is not disciplinary action for the purposes of section 36.

35(7)

If a worker who receives a record under subsection (4)(d) is of the opinion that an imminent danger still exists, the worker may file a complaint with an officer.

35(8)

An officer who receives a complaint under subsection (7) shall prepare a written record of the worker's complaint, the investigation and the action taken and shall give the worker and the employer a copy of the record.

35(9)

A worker or an employer who receives a record under subsection (8) may request a review of the matter by the Council by serving a notice of appeal on a Director of Inspection within 30 days from the date of receipt of the record.

35(10)

After considering the matter, the Council may by order

- (a) dismiss the request for a review, or
- (b) require the employer to eliminate the imminent danger.

35(11)

An appeal lies to the Court of Queen's Bench from an order of the Council on a question of law or a question of jurisdiction and on hearing the matter the Court may make any order, including the awarding of costs, that the Court considers proper.

35(12)

An appeal under subsection (11) shall be made by way of application within 30 days from the date that the order of the Council is served on the person appealing the order of the Council.

35(13)

The commencement of an appeal under subsection (11) does not operate as a stay of the order of the Council being appealed from except insofar as a judge of the Court of Queen's Bench so directs.

OH&S REGULATION PART 1 - GENERAL

SECTION 14 DUTIES OF WORKERS

(1)

A worker who is not competent to perform work that may endanger the worker or others must not perform the work except under the direct supervision of a worker who is competent to perform the work.

(2)

A worker must immediately report to the employer equipment that

- (a) is in a condition that will compromise the health or safety of workers using or transporting it,
- (b) will not perform the function for which it is intended or was designed,
- (c) is not strong enough for its purpose, or
- (d) has an obvious defect.

(2.1)

A worker who believes that an unsafe or harmful work site condition or act exists or has occurred shall immediately report it to the employer.

(3)

If a regulation or an adopted code imposes a duty on a worker,

- (a) the duty must be treated as applying to circumstances and things that are within the worker's area of occupational responsibility, and
- (b) the worker must perform that duty.

SECTION 15 SAFETY TRAINING

(1)

An employer must ensure that a worker is trained in the safe operation of the equipment the worker is required to operate.

(2)

An employer must ensure that the training referred to in subsection (1) includes the following:

- (a) the selection of the appropriate equipment;
- (b) the limitations of the equipment;
- (c) an operator's pre-use inspection;
- (d) the use of the equipment;
- (e) the operator skills required by the manufacturer's specifications for the equipment;
- (f) the basic mechanical and maintenance requirements of the equipment;
- (g) loading and unloading the equipment if doing so is a job requirement;
- (h) the hazards specific to the operation of the equipment at the work site.

(3)

If a worker may be exposed to a harmful substance at a work site, an employer must

- (a) establish procedures that minimize the worker's exposure to the harmful substance, and
- (b) ensure that a worker who may be exposed to the harmful substance
 - (i) is trained in the procedures,
 - (ii) applies the training, and
 - (iii) is informed of the health hazards associated with exposure to the harmful substance.

(4)

A worker must participate in the training provided by an employer.

(5)

A worker must apply the training referred to in subsections (1) and (3).

OH&S CODE PART 3 SPECIFICATIONS AND CERTIFICATIONS

FOLLOWING SPECIFICATIONS

12

An employer must ensure that

- (a) equipment is of sufficient size, strength, design and made of suitable materials to withstand stresses imposed on it during its operation and to perform the function for which it is intended or was designed,
- (b) the rated capacity or other limitations on the operation of the equipment, or any part of it, or supplies as described in the manufacturer's specifications or specifications certified by a professional engineer, are not exceeded,
- (c) modifications to equipment that may affect its structural integrity or stability are performed in accordance with the manufacturer's specifications or specifications certified by a professional engineer, and
- (d) equipment and supplies are erected, installed, assembled, started, operated, handled, stored, serviced, tested, adjusted, calibrated, maintained, repaired and dismantled in accordance with the manufacturer's specifications or the specifications certified by a professional engineer.

MANUFACTURER'S AND PROFESSIONAL ENGINEER'S SPECIFICATIONS

13(1)

If this Code requires anything to be done in accordance with a manufacturer's specifications, an employer may, instead of complying strictly with the manufacturer's specifications, comply with modified specifications certified by a professional engineer.

13(2)

If this Code requires anything to be done in accordance with manufacturer's specifications and they are not available or do not exist, an employer must

- (a) develop and comply with procedures that are certified by a professional engineer as designed to ensure the thing is done in a safe manner, or
- (b) have the equipment certified as safe to operate by a professional engineer at least every 12 calendar months.

CERTIFICATION BY A PROFESSIONAL ENGINEER

14(1)

If this Code requires that procedures or specifications be certified by a professional engineer, the certification must

- (a) be in writing, and
- (b) be stamped and signed by the professional engineer.

14(2)

Unless the document states otherwise, certification by a professional engineer implies that the procedures or specifications certified are fit and safe for the workers affected by them.

APPROVED EQUIPMENT

15

If this Code requires equipment to be approved by a named organization, an employer must use best efforts to ensure that the seal, stamp, logo or similar identifying mark of that organization is on the equipment and legible.

OH&S CODE PART 6 - CRANES, HOISTS AND LIFTING DEVICES

APPLICATION

59(1)

This part applies to lifting devices, including cranes and hoists, with a rated load capacity of 2000 kilograms or more.

59(2.1)

A hoist may only be used for vertical lifting or lowering if it complies with this part and is designed and manufactured for vertical lifting and lowering.

59(4)

Despite subsection (1), an employer must ensure that a lifting device with a rated load capacity of less than 2000 kilograms has the rated load capacity of the equipment shown on the equipment.

NOT COMMERCIALY MANUFACTURED

60

If a lifting device is not commercially manufactured, an employer must ensure that it is fit and safe for use as a lifting device and it is certified by a professional engineer.

IDENTIFICATION OF COMPONENTS

61

An employer must ensure that all major structural, Mechanical and electrical components of a lifting device are permanently and legibly identified as being components of a specific make and model of lifting device.

RATED LOAD CAPACITY

62(1)

An employer must ensure that a lifting device has a plate or weatherproof label permanently secured to it that legibly shows

The manufactures rated load capacity,

- a) The manufactures name, and
- b) The model, serial number and year of manufacturer or shipment date.

62(2)

If a lifting device is not commercially manufactured, an employer must ensure that it has a plate or weatherproof label permanently secured to it that legibly shows the rated load capacity according to the professional engineer's certification.

LOAD CHARTS

63(1)

An employer must ensure that a mobile crane or boom truck is equipped at all times with load charts showing the rated load capacity of the mobile crane or boom truck at all permitted boom angles and boom radii.

63(2)

An employer must ensure that a tower crane has a load chart

- (a) conspicuously and permanently secured to the cab, and
- (b) showing the manufacturer's rated capacity loads at various radii of a two-part line and a four-part line separately.

OPERATOR REQUIREMENTS

64(1)

An employer must ensure that a lifting device be operated only by a competent worker authorized by the employer to operate the equipment.

64(2)

At the employer's request an operator, before operating a lifting device, must be able to demonstrate that the worker is **competent** in the operation of the equipment and knowledgeable about load charts and the code of signals for hoisting operations.

64(3)

No worker other than a competent worker authorized by the employer may operate a lifting device.



*“Competent” in regards to a worker means adequately **qualified**, suitably **trained** and with sufficient **experience** to safely perform work without supervision or with only a minimal degree of supervision)*

Competency comes with experience and hands on training under the direct supervision of a competent worker, this crane course does not make a worker competent, it's up to the worker's supervisor to deem a worker competent.

64(4)

Before operating a lifting device, the operator must be familiar with all the recent entries in its log book. An employer must set up a paper or electronic log book for each lifting device at a work site. The employer must ensure that the log book is readable available for inspection by an officer at any time.

LOG BOOKS

65(1)

An employer must set up a paper or electronic log book for each lifting device at a work site

65(1.1)

Despite subsection (1), the log book requirement does not apply to manually operated hoists.

65(2)

The employer must ensure that

- a) The log book is readily available for inspection by an officer at any time,
- b) the most current log book of a mobile crane accompanies it or is available to the operator at all times, and
- c) If ownership of a lifting device is transferred to a new owner, the log book is transferred to the new owner.

65(3)

The employer must ensure that the following details are entered into the log book.

- a) The date and time when any work was performed on the lifting device.
- b) Length of time in lifting service.
 - i) (recorded as hours of service if the lifting device is supplied by the manufacturer with an hour meter, or
 - ii) if required by the manufacturer's specifications)
- c) All defects or deficiencies and when they were detected.
- d) Inspections, including examinations, checks and tests, that were performed, including those in the manufacturer's specifications.
- e) Repairs or modifications performed.
- f) A record of certification under section 73;
- g) Any matter or incident that may affect the safe operation of the lifting device.
- h) Any other operational information specifically identified by the employer.

65(4)

The employer must ensure that each entry in a paper log is signed by the person doing the work.

65(5)

The employer must ensure that each entry in an electronic log book identifies the person doing the work.

PREVENTING AN UNSAFE LIFT

66

If the operator of a lifting device has any doubts as to the safety of workers in the vicinity of the lift, the operator must not move any equipment or load until the operator is assured that the working conditions are safe.

PREVENTING COLLISIONS

67

An employer must ensure that procedures are developed to prevent collisions if two or more lifting devices are in use and there is the potential for a collision between them, their loads or component parts.

LOAD WEIGHT

68

An employer must ensure that the operator of a lifting device, the rigger supervised by the operator and the person in charge of the lift are provided with all the information necessary to enable them to readably and accurately determine the weight of the load to be lifted.

LIFT CALCULATION

68.1

An employer must ensure that a lift calculation is completed for any lift that exceeds 75% of a crane's rated capacity.



TDM's Critical Lift Plan (form #070) must be completed for any lift that exceeds 75% of the crane's capacity.

LOADS OVER WORK AREAS

69(1)

An employer must ensure that work is arranged, if it is reasonable practicable, so that a load does not pass over workers.

69(2)

An operator of a lifting device must not pass the load on the device over workers unless

- (a) no other practical alternative exists in the circumstances, and
- (b) the workers are effectively warned of the danger.

69(3)

A worker must not stand or pass under a suspended load unless the worker has been effectively warned of the danger and the operator of the lifting device knows the worker is under the suspended load.



*TDM policy dictates that an operator of a lifting device **never** transfer a load over other workers.*

If required, workers must be asked to make way.

69(4)

The operator of a lifting device that is travelling with a load must ensure that the load is positioned as close to the ground or grade as possible.

TAG AND HOISTING LINES

70(1)

If a worker is in danger because of the movement of the load being lifted, lowered or moved by a lifting device, an employer must ensure that,

- (a) a worker uses a tag line of sufficient length to control the load.
- (b) the tag line is used in a way that prevents the load from striking the worker controlling the tag line
- (c) a tag line is used when it allows worker separation from the load.

70(2)

An employer must ensure that tag lines of non-conductive synthetic rope are used when there is a danger of contact with energized electrical equipment.

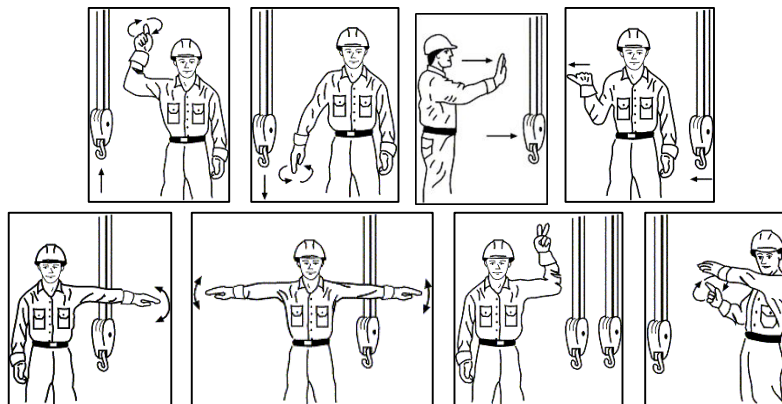
70(3)

An employer must ensure that tag lines are not used in situations where their use could increase the danger to workers.

HAND SIGNALS

71

An employer must ensure that hand signals necessary to ensure a safe hoisting operation are given in accordance with **section 191** by a competent signaller designated by the employer.



CONTROLS

72(1)

See section 95.1.

72(2)

Repealed.

72(3)

The employer must ensure that an operator who uses a remote control to operate a lifting device is visually distinguishable from other workers at the site.

Note:



At TDM, "remote control" refers exclusively to wireless and radio operated control systems.

Pendant controls are not regarded as remote control devices.

REPAIRS AND MODIFICATIONS

73(1)

An employer must ensure that structural repairs or modifications to components of a lifting device are.

- a) Made only under the directions and control of a professional engineer, and
- b) Certified by the professional engineer to confirm that the workmanship and quality of materials used has restored the components to not less than their original capacity.

73(2)

If structural repairs or modifications are made, the employer must ensure that.

- a) The repairs or modified components are individually and uniquely identified in the log book and on the components, and
- b) The professional engineer's certification makes reference to those components and their identification.

CONTAINERS FOR HOISTING

74(1)

An employer must ensure that a container used for a load being lifted by a hoist is designed for that particular purpose and bears a marking to indicate its maximum load rating.

74(2)

A person must not use an oil drum or similar container as a container for a load being lifted by a hoist unless the drum or container is hoisted in a cage designed for that purpose.

A-FRAMES AND GIN POLES

75

An employer must ensure that an A Frame or gin pole

- a) Is not inclined more than 45 degrees from the vertical.
- b) is equipped with a boom stop, and
- c) has the sheave and cap of its rigging attached securely enough to the gin pole to withstand any loads to which the assembly may be subjected.

SUSPENDED PERSONNEL BASKETS

75.1(1)

An employer must ensure that

- a) a commercially manufactured suspended personnel basket is erected, used, operated and maintained in accordance with the manufacturer's specifications or specifications certified by a professional engineer, or
- b) A suspended personnel basket that is not commercially manufactured is designed and certified by a professional engineer.



75.1(2)

Despite section 147, **(Life line safety)** if it is not practicable to provide a separate personal fall arrest system using a vertical life line for each worker in the man basket, an employer must ensure that

- a) a separate support is attached between the suspended personnel basket and the hoist line above the hook assembly that is capable of withstanding the weight of the personnel basket, materials, equipment and workers should the hook assembly fail, and
- b) each worker within the personnel basket is wearing a separate personal fall arrest system attached to the personnel basket.

HAND OPERATED HOISTS - HOLDING SUSPENDED LOAD

80

An employer must ensure that a hand operated hoist is provided with a device capable of holding the total load suspended safely under all operating conditions.

OVERHEAD CRANES - ELECTRICAL COMPONENTS AND FUNCTIONS

93

A bridge, jib, monorail, gantry or overhead travelling crane must meet the design requirements for electrical components and functions of

- a) CSA Standard C22.1, Canadian electrical code, Part 1, section 40, and
- b) CSA Standard C22.2 NO.33-M1984 (R2004), Construction and Tests of Electric Cranes and Hoists.



MAINTENANCE AND INSPECTION.

94

A bridge, jib, monorail, gantry or travelling crane must meet the safety requirements of CSA STANDARD CAN/CSA-B167-96 (R2007) *Safety Standard for Maintenance and Inspection of Overhead Cranes, Gantry Cranes, Monorails, Hoist and Trolleys.*

SAFE MOVEMENT

95

An employer must ensure that a crane operating on rails, tracks or trolleys.

- a) Has a positive stop or limiting device on the crane or on the rails, tracks or trolleys to prevent it from overrunning safe limits or contacting other equipment that is on the same rail, track or trolley.
- b) Is equipped with an overspeed limiting device,
- c) Has a positive means of ensuring that the rails, tracks or trolleys cannot be spread or misaligned,
- d) Has sweep guards installed to prevent material on the rail, track or trolley from dislodging the crane, and.
- e) Has a bed designed to carry all anticipated loads.

CONTROLS

95.1

An employer must ensure that the controls of an overhead crane are of a constant manual pressure type.



OH&S CODE PART 12 GENERAL SAFETY PRECAUTIONS

SIGNALLERS

191(1)

If this code requires signals to be given by a designated signaller, an employer must designate a competent worker to give the signals.

191(2)

An employer must ensure that, if the designated signaller gives hand signals, the signaller wears a highly visible vest, armband or other piece of clothing that clearly identifies the worker as a designated signaller.

191(3)

A designated signaller using hand signals must wear the vest, armband or other piece of clothing required by the employer under subsection (2)

191(4)

Before giving a signal to proceed, a designated signaller must ensure there are no hazards in the vicinity.

191(5)

If a signaller is designated, an equipment operator must take signals only from the designated signaller.

191(6)

An employer must ensure that only one designated signaller at a time gives signals to an equipment operator.

191(7)

Despite subsections (5) and (6), an equipment operator must take a STOP signal from a worker who is not a designated signaller.

191(8)

Despite subsections (5) and (6), if signals cannot be transmitted properly between a designated signaller and an equipment operator, an employer must ensure that.

- a) Additional designated signallers are available to transmit signals, or
- b) A means of ensuring clear and complete communication other than using designated signallers is provided.

OH&S CODE PART 21 - RIGGING

BREAKING STRENGTH

292(1)

An employer must ensure that rigging is not subjected to a load of more than

- a) 10 percent of the breaking strength of the weakest part of the rigging, if a worker is being raised or lowered,
- b) subject to section 292.1, 20 percent of the ultimate breaking strength of the weakest part of the rigging in all other situations unless the manufacturer has fatigue rated the rigging in accordance with CEN Standard EN 1677-1: 2000, *Components for slings – Part 1: Forged steel components grade 8*, and
- c) subject to section 292.1, if the rigging is fatigue rated in accordance with CEN Standard EN 1677-1: 2000 and a worker is not being raised or lowered, the maximum load must not exceed 25 percent of the ultimate breaking strength.

292(2)

Despite subsection (1), an employer may use a dedicated rigging assembly designed and certified for a particular lift or project by a professional engineer, but the dedicated rigging assembly must be re-rated to comply with subsection (1) before it is used for another lift or project.

SAFETY FACTORS

292.1(1)

Subject to section 292, an employer must ensure that rigging components are rated relative to their ultimate breaking strength in accordance with the following safety factors:

- | | |
|------------------------------------|-------------|
| a) running lines | 3.5 to 1; |
| b) non-rotating hoist lines | 5 to 1; |
| c) tigger lines/blocks for pulling | 3 to 1; |
| d) pendant lines/guy lines | 3 to 1; and |
| e) winch lines | 2 to 1. |

292.1(2)

An employer must ensure that rigging components or hoisting lines that are used in any towing operation are not used for any hoisting operation.

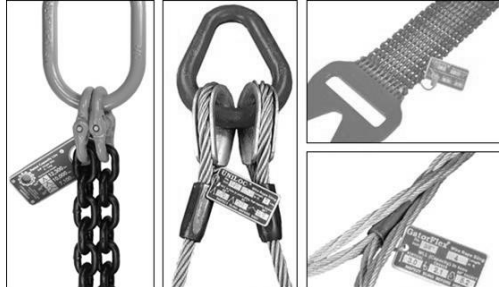


Towing operations regularly inflict “shock loading” on the lines used which affects their reliability in lifting operations.

LOAD RATINGS

293(1)

An employer must ensure that the maximum load rating of the rigging, as determined by the rigging manufacturer or a professional engineer, is legibly and conspicuously marked on the rigging.



293(2)

Despite subsection (1), if it is not practicable to mark the rigging, the employer must ensure the maximum load rating of the rigging is available to the workers at the work site.

INSPECTION

294

An employer must ensure that rigging to be used during a work shift is inspected thoroughly prior to each period of continuous use during the shift to ensure that the rigging is functional and safe.

PROHIBITION

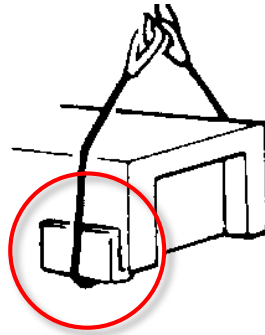
295

A worker must not use rigging that does not comply with this Part.

RIGGING PROTECTION

296

An employer must ensure that sharp edges on loads to be hoisted are guarded to prevent damage to the slings or straps of the rigging.



STANDARDS

297(1)

An employer must ensure that wire rope, alloy steel chain, synthetic fibre rope, metal mesh slings and synthetic fibre slings manufactured on or after July 1, 2009 meet the requirements of ASME Standard B30.9-2006, *Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks and Slings*.

297(2)

An employer must ensure that below-the-hook lifting devices, other than slings, meet the requirements of ASME Standard B30.20-2006, *Below the Hook Lifting Devices*.

297(3)

Despite subsection (2), an employer may use a capacity data sheet to label a spreader bar with its rated capacity.



297(4)

Where a capacity data sheet is used in accordance with subsection (3), an employer must ensure that the data sheet and corresponding spreader bar are identified by a unique numbering system.

**SLINGS****298(1)**

An employer must ensure that synthetic fibre slings are permanently and legibly marked or appropriately tagged with the following:

- the manufacturer's name or trade mark;
- the manufacturer's code or stock number;
- the safe working load for the types of hitches permitted; and
- where appropriate, the type and material of construction.

**298(2)**

An employer must ensure that slings at a worksite are not subjected to pull tests beyond 100 percent of their rated load capacity.

ROPE WOUND ON DRUM**299(1)**

An employer must ensure that rope on a winding drum is securely fastened to the drum.

299(2)

An employer must ensure that the number of wraps of rope remaining at all times on a drum

- complies with the manufacturer's specifications for the rope and the drum, or
- if there are no manufacturer's specifications, is not less than 5 full wraps.

CABLE CLIPS

300(1)

An employer must ensure that U-bolt type clips used for fastening wire rope are installed

- a) so that the U-bolt section of the clip bears on the short or “dead” side of the rope,
- b) so that the saddle of a clip bears on the long or “live” side of the rope, and
- c) using the number and with the spacing that complies with the specifications in Schedule 5.



300(2)

An employer must ensure that cable clips used for fastening wire rope are installed, and torqued to the manufacturer’s specifications or, in the absence of manufacturer’s specifications, to the values specified in Schedule 5.

300(3)

An employer must ensure that double-saddle clips (fist clips) used for fastening wire rope are installed using the number and the spacing and torque that complies with the specifications in Schedule 5.



300(4)

An employer must ensure that double base clips used for fastening wire rope are installed with a spacing that is not less than 6 times the diameter of the rope.

FERRULES

301(1)

If a ferrule is used to form an eye loop in a wire rope and

- a) the ends of the splice are visible beneath the ferrule, or
- b) the ferrule is identified as covering a “Flemish eye” splice,

the employer must ensure that the ferrule is commercially manufactured of steel and properly swaged onto the splice.



301(2)

Despite subsection (1), if an aluminum alloy ferrule must be used, an employer must ensure that the ferrule is

- a) commercially manufactured,
- b) identified as being made of aluminum alloy, and
- c) properly swaged onto the splice.

MATCHING COMPONENTS

302(1)

An employer must ensure that the wire ropes, sheaves, spools and drums used in rigging have a diameter of not less than the diameter specified by the manufacturer for use in that circumstance.

302(2)

An employer must ensure that the rope used in rigging is of the correct size for the sheave, spool or drum over which the rope passes.

302(3)

An employer must ensure that the grooving of wire rope sheaves is of the correct size for the wire rope used.

302(4)

An employer must ensure that end fittings and connectors used on a wire rope conform to the manufacturer’s specifications as to number, size and method of installation.

302(5)

An employer must ensure that rigging blocks are constructed and installed so that the ropes cannot jump off the sheaves.

SAFETY LATCHES

303(1)

An employer must ensure that a hook has a safety latch, mousing or shackle if the hook could cause injury if it is dislodged while in use.



303(2)

Despite subsection (1), if a competent worker disconnecting the hook would be in danger if the hook has a safety latch, mousing or shackle, the employer may use another type of hook.

303(3)

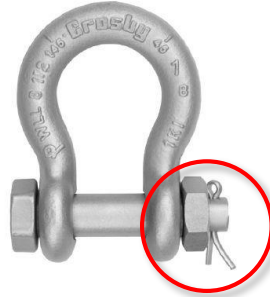
Despite subsection (1), an employer may use a sorting hook for hoisting a skeleton steel structure or for performing similar operations if a sorting hook is safer to use than a hook with a safety latch, mousing or shackle.



303(4)

During a hoisting operation in a caisson, an employer

- a) must not use a spring-loaded safety latch hook, and
- b) must use a shackle assembly consisting of a pin fully shouldered into the eyes of the shackle and secured by a nut that is prevented from rotating by a cotter pin.

**MAKESHIFT RIGGING AND WELDING****304**

An employer must ensure that rigging does not have

- a) makeshift fittings or attachments, including those constructed from reinforcing steel rod, that are load bearing components,
- b) rigging and fittings that are repaired by welding unless they are certified safe for use by a professional engineer after the repair is completed, or
- c) alloy steel chain that is welded or annealed.

REJECTION CRITERIA - SYNTHETIC FIBRE SLINGS**305(1)**

An employer must ensure that a synthetic fibre web sling is permanently removed from service if it is damaged or worn as follows:

- a) the length of the edge cut exceeds the web thickness;
- b) the depth of an abrasion is more than 15 percent of the webbing thickness, taken as a proportion of all plies;
- c) the total depth of the abrasion on both sides of the webbing is more than 15 percent of the webbing thickness, taken as a proportion of all plies;
- d) the depth of the warp thread damage is up to 50 percent of the webbing thickness and the damage
 - i) is within 25 percent of the sling width of the edge, or
 - ii) covers 25 percent of the sling width,
- e) the warp thread damage is as deep as the sling is thick
 - i) in an area that is within 25 percent of the sling width of the edge, or
 - ii) over an area that is more than 12.5 percent of the width of the sling;
- f) weft thread damage allows warp threads to separate over an area that is wider than 25 percent of the sling width and longer than twice the sling width.

305(2)

An employer must ensure that a synthetic fibre web sling is permanently removed from service if

- a) part of the sling is melted, charred or damaged by chemicals,
- b) stitches in load bearing splices are broken or worn, or
- c) end fittings are excessively pitted or corroded, cracked, distorted or broken.

305(3)

An employer must ensure that a synthetic fibre web sling is permanently removed from service if it is damaged in such a way that the total effect of the damage on the sling is approximately the same as the effect of any one of the types of damage referred to in subsections (1) or (2).

305(4)

An employer must ensure that a synthetic fibre web sling that is permanently removed from service under this section is physically altered to prevent its further use as a sling.

REJECTION CRITERIA - WIRE ROPE

306(1)

An employer must ensure that wire rope is permanently removed from service if

- a) wear or corrosion affects individual wires over more than one third of the original diameter of the rope,
- b) there is evidence that the rope structure is distorted because of bulging, kinking, bird-caging or any other form of damage,
- c) there is evidence of heat or arc damage, or
- d) the normal rope diameter is reduced, from any cause, by more than
 - i) 0.4 millimetres if the normal rope diameter is 8 millimetres or less,
 - ii) 1 millimetre if the normal rope diameter is more than 8 millimetres and less than 20 millimetres,
 - iii) 2 millimetres if the normal rope diameter is 20 millimetres or more and less than 30 millimetres, and
 - iv) 3 millimetres if the normal rope diameter is 30 millimetres or more.

306(2)

An employer must ensure that a running wire rope is permanently removed from service

- a) if six or more randomly distributed wires are broken in one rope lay, or
- b) if three or more wires are broken in one strand in one rope lay.

306(3)

An employer must ensure that a stationary wire rope such as a guy line is permanently removed from service

- a) if three or more wires are broken in one rope lay in sections between end connections, or
- b) if more than one wire is broken within one rope lay of an end connection.

306(4)

An employer must ensure that wire rope that does not rotate because of its construction is permanently removed from service

- a) if there is evidence of the damage referred to in subsection (1),
- b) if two randomly distributed wires are broken in six rope diameters, or
- c) if four randomly distributed wires are broken in 30 rope diameters.

REJECTION CRITERIA - METAL MESH SLINGS**307**

An employer must ensure that a metal mesh sling is removed from service if

- a) there is a broken weld or a broken brazed joint along the sling edge,
- b) a wire in any part of the mesh is broken,
- c) corrosion has reduced a wire diameter by 15 percent,
- d) abrasion has reduced a wire diameter by 25 percent,
- e) there is a loss of flexibility because the mesh is distorted,
- f) the depth of the slot is increased by more than 10 percent because the choker fitting is distorted,
- g) the width of the eye opening is decreased by more than 10 percent because either end fitting is distorted,
- h) the original cross-sectional area of metal is reduced by 15 percent or more at any point around the hook opening or end fitting,
- i) either end fitting is distorted, or
- j) an end fitting is cracked.

REJECTION CRITERIA - ELECTRIC ARC DAMAGE**308**

An employer must ensure that a component of rigging that has been contacted by an electric arc is removed from service unless a professional engineer certifies that it is safe to use.

REJECTION CRITERIA - DAMAGED HOOKS**309**

An employer must ensure that a worn, damaged or deformed hook is permanently removed from service if the wear or damage exceeds the specifications allowed by the manufacturer.

3 Crane Operation



QUALIFICATIONS

Crane operation, to be safe and efficient, requires

- Skill
- extreme care and good judgment
- alertness and concentration and
- rigid adherence to proven safety rules and practices.

In general practice, no person should be permitted to operate a crane:

- Who cannot speak the appropriate language or read and understand the printed instructions;
- Who is not of legal age to operate this type of equipment;
- Whose hearing or eyesight is impaired (unless suitably corrected - with good depth perception);
- Who may be suffering from heart issues or other ailments which might interfere with the operator's safe performance;
- Unless the operator has been properly instructed;
- Unless the operator has demonstrated his instructions through practical operation, and has a thorough knowledge of the equipment;
- Unless the operator is familiar with hitching equipment and practices;
- Unless the operator becomes completely familiar with applicable ANSI standards and current safety requirements of the Occupational Safety and Health Act (OH&S).

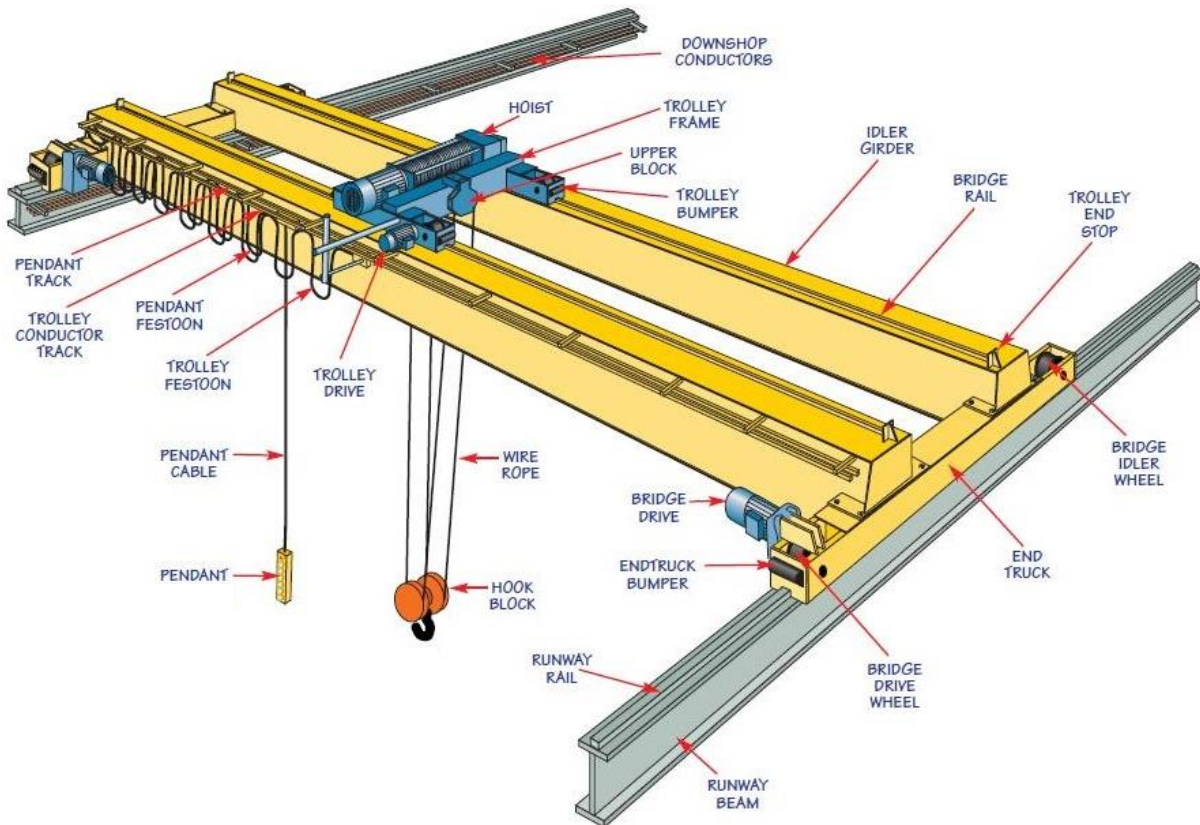
PRE-LEARNING

Before operating the crane, you should carefully read and study the operation manual supplied with the crane by the crane manufacturer and note any special instructions not given previously by the proper instructor or supervisor.

Before using the crane, you must perform a pre use inspection. If the crane fails to respond properly to the pendant control buttons, follow our lock out / tag out (LOTO) policy for defective equipment and lock out the crane immediately. Notify your supervisor of the situation.

Never operate a defective crane.

HARDWARE



COMPONENTS

The main parts of each of our bridge cranes are:

- The runways – rails located and supported along the walls
- The bridge – spanning the runways, moves the length of the building
- A trolley or trolleys – spanning the bridge on their own rails, able to move the length of the bridge (the width of the building)
- A hoist or hoists – raise and lower the loads

The lifting capacity of our bridge cranes range from 5 to 40 tons. Capacities are determined by hoist configuration. (Two 20-ton hoists on the same crane means you can lift up to 40 tons on the one crane.)

The cranes are controlled by a control pendant.



Note: Radio control units are available but TDM has deemed them unsafe for use in this environment.

TDM only uses pendant-style controls.

COMPONENT GUIDE

Component	Notes
Bridge	<p>The bridge has wheels on its ends which are seated on the rails. The bridge travels on rails the full length of the runway.</p> <p>The bridge's movement is powered by electric motors.</p> <p><i>(Both the bridge and the trolleys are designed with a safety feature that will only allow the crane assembly to drop about one inch should an axle fail.)</i></p> <p>The capacity of the crane will be marked on the bridge.</p>
Brakes	<p>The motors have brakes which automatically activate when the control button is released.</p> <p>When the brakes are working correctly, the bridge will coast a short distance to come to a smooth stop. If the brakes are not working properly, the bridge will continue coasting (beyond the usual distance) after the brakes are on.</p>
Power supply	<p>There is a main power shut-off at floor level that shuts off the power to the crane. Power flows from this shut-off up to the conductors. Electrical power is supplied to the bridge crane through the conductors and collectors. (Conductors and collectors must be clear of any debris.) There is a main contactor through which the power flows and is then distributed to the motors on the crane. Festooned, or suspended, electrical cables supply power to the trolley and the hoist. These cables must be neat and not in contact with any parts of the machine.</p>
Limit switches	<p>The cranes have switches that limit how far a load can be lifted.</p> <p>A limit switch is a safety device positioned in such a way that whenever the hoist reaches its limit, the hoist stops.</p> <p>Some crane control pendants have an override button that allows two cranes on the same runway to contact each other at slow speed.</p>
Bumpers and stops	<p>Safety stops are in place at the ends of the rails, both on the runways and bridges.</p> <p>End stops prevent the bridge from running off the end of the runway. Trolley stops on the bridges prevent the trolleys from travelling too far to the sides.</p> <p>Rubber bumpers help absorb the impact should a crane or trolley run into the end stops.</p>
Trolley	<p>The trolley moves back and forth on the bridge carrying the hoist width-wise across the building.</p> <p>The trolley operates similar to the bridge itself with motors, brakes, and safety stops.</p>
Hoist	<p>A hoist lifts loads by winding wire rope onto a drum.</p> <p>All hoists have brakes to hold the load.</p>
Wire rope	<p>Wire ropes winds through the lifting blocks and onto the hoist drum.</p> <p>They must be in good repair. This means no broken strands, kinks, wear, or corrosion.</p>

Component	Notes
	The wire rope must be spooled on the hoist drum evenly.
Hook	<p>Hooks must</p> <ul style="list-style-type: none"> • have a capacity that matches the rest of the crane system • have safety clips (safety latches) • be within the manufacturer's specifications for shape (not sprung). • not be opened wider than 15% of the original design • not be bent laterally more than 10 degrees. • not be repaired if damaged. They must be replaced.
Pendant Controls	<p>The control buttons allow the operator to raise and lower loads with the hoist and move the crane in all directions.</p> <p>The pendant is attached to the crane by an electrical cable. A separate cable or chain supports the weight of the pendant control and prevents damage to the electrical cable.</p> <p>The function of each button should be clearly marked on the pendant.</p> <p>The buttons are two-speed.</p> <ul style="list-style-type: none"> • Depressing halfway = Slow speed. • Depressing fully = High speed. <p>Some pendants have switches for controlling one or both trolleys if equipped.</p> <p>All pendants have emergency stop buttons. The emergency stop button turns off all power to the crane.</p>
Load Limiter	<p>Load limiters <i>may</i> be configured on some cranes to prevent overloading of the crane.</p> <p>A load limiter shuts off the power to the crane should the crane be overloaded. If this does occur, notify your supervisor.</p> <p>The most effective overloading prevention begins with careful rigging and move planning.</p>

CONFIGURATIONS

All overhead cranes operating at our facility are dual-bridge types as follows:

- Single trolley / single hoist units
- 16 ton
- 20 ton and
- 30 ton
- Dual trolley / single hoist units
- 20 ton (x2)
- Single trolley / dual hoist unit
- 5 ton
- 15 ton and
- 20 ton

ORIENTATIONS

All our overhead cranes have the four points of the compass (north, south, east and west) marked on the underside of the bridge for your reference. You should familiarize yourself with the orientation of the shop and cranes.

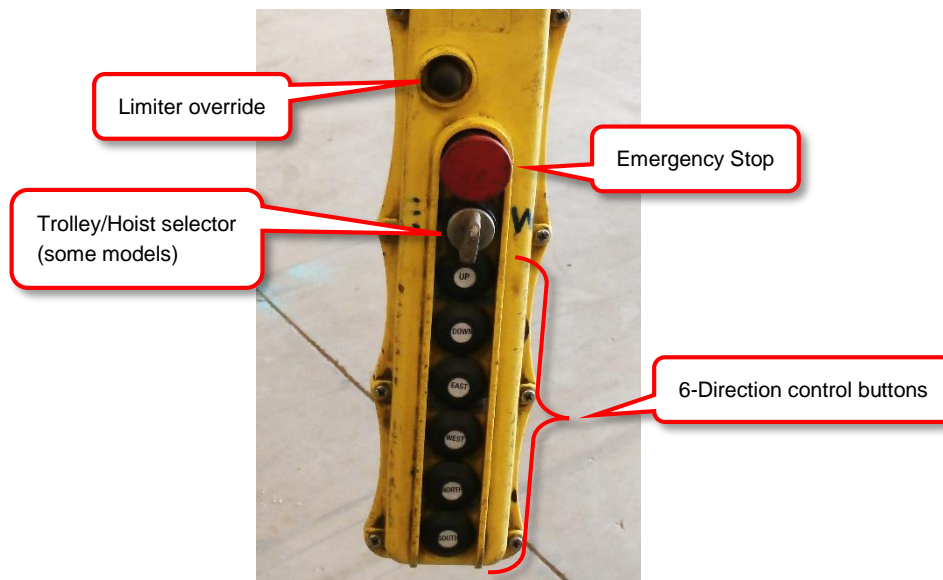
The corresponding directions are marked on the pendant movement control buttons.

It's important to know which direction is which. For example, if the buttons are marked North, South, East, West, make sure you know what direction you are facing in the building.

The two remaining directions the crane operates in are UP and DOWN, of course. These are also marked on the appropriate pendant control buttons.



LEARNING THE CONTROLS



Crane Control Pendant

Having read the operator's manual and performed a pre-use inspection, you are now ready to try the crane with power applied.

After checking to be sure no one is near the crane, energize the crane by twisting and pulling the Emergency stop button so that the power is "ON". (Press this button straight in to shut off the power in an emergency.)

RAISING AND LOWERING

Try the hoisting motion first.

Press the "UP" button gently. Observe the speed increase in relation to the steps in the controller. Try to feel the steps in a pendant button.

Move the hook to a position near the upper hook position and slowly inch the hook into the upper limit stop position. The limit switch should cause the hoisting motion to stop automatically at the upper limit of travel.

Lower the hook to the floor. The lower limit switch should prevent the hook from contacting the floor.

Optional: When the hoist is reeled out to its maximum length, it's an opportunity to do a visual inspection of the hoist cables.



If any malfunction of either the hoist brake or the limit switches is suspected, the crane must be locked out and your supervisor notified.

The hoist limit switches should never be used as an operating control for stopping the load. They are to be considered as an emergency aid only.

TROLLEY MOVEMENT

Get a feel for the trolley movement along the bridge, slow and fast.

Observe the characteristics and practice coming to stop gently. Coasting to a stop is a good technique.

Also experiment with movement to extreme ends of the bridge. The trolley has rubber bumpers mounted on the end stops.

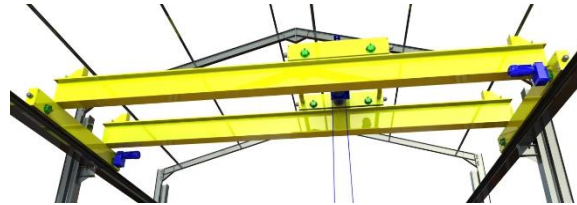


BRIDGE MOVEMENT

Next, try the bridge motion, first making sure that the first movement is in the direction the bridge is free to travel.

Observe the stopping distance of the bridge.

The bridge carries a lot of mass to move even without a load.



REMEMBER: GOOD operators always remember and follow four simple rules:



1. Start all motions slowly, by pushing the button step by step until the fastest safe speed is reached.
2. Stop slowly, by bringing the button to the "off" position step by step so as to minimize "swinging" of the load and unnecessary wear of the brakes.
3. Learn to judge the drift of each motion of the crane after power is removed. Proper use of this drift will facilitate spotting of the load and minimize wear of crane components.
4. Handle the load in a safe manner with the area free of personnel and other obstructions.

USING THE CONTROLS

Pendant controls should be in good repair - never use a damaged control. Ensure all the buttons are marked.

If you're unsure about what the function of a button is, ask.

Know in advance of operation whether the controls are single speed or two speed (for example, if you push the button in halfway, the speed is slower than if it is pushed in all the way).

Control buttons are two-speed. Pressing halfway is slow speed. Pressing all the way is high speed. Use the slow speed to start and finish hoisting or traversing the load.

All cranes respond differently to the controls. Some respond quicker than others. You will learn the characteristics of any given crane by using it. (Typically, the broader the span of the bridge, the slower the crane will respond to the controls.)

Make sure you fully understand the function of the emergency shutoff switch on the pendant.

A good crane operator is one who can move a load smoothly. Start off any movement of the load slowly. This is best accomplished by ensuring that all speeding up and slowing down is done smoothly and evenly. Never change direction suddenly.



Never release or throw a pendant from an elevated position (such as roof top of a structure) or allow a pendant to swing uncontrolled.

A swinging pendant can strike an object, person or structure, causing injury or damage. Further, a damaged pendant could trigger a serious crane malfunction.

BRAKE CHECK

Before making a heavy lift, raise the load a few inches off the floor and hold. Observe to ensure the load remains in place.

Should the load slowly settle back down to the floor, this indicates the brakes are bad. Put the load back down on the floor securely, disconnect the rigging and lockout the crane. Notify your supervisor.

SWING CONTROL

When you first move a load horizontally, inertia causes the load to lag behind the crane.

When the crane stops, momentum keeps the load moving.

The combination of starting and stopping results in the load swinging back and forth somewhat.

The heavier the load, the more the swing.

This is an important reason why operating the controls smoothly is important.

Make sure you have enough space in case the load does swing.

A competent crane operator can learn to easily stabilize a swinging load by moving the crane in the right direction at just the right moment to counteract the momentum of the swing.

When you get the feel for the crane in your work area, you will know exactly when to press the buttons to control a swinging load.

THINGS TO AVOID

Shock Loading occurs when sudden changes in weight changes the stress on the lifting equipment in a short time. Causes include rapid starts and stops in hoisting or loads that shift or slip during lifting.

The crane is designed to lift vertically only and can only transport a load that is suspended. **Side Loading** takes place when tension is placed on the lifting lines in a direction other than vertical.

Typically, this is what happens when attempting to lift a load that is not directly under the hoist, or attempting to drag a load along the ground.



After a crane has experienced either Shock Loading or Side Loading, TDM policy dictates the crane must be recertified by the manufacturer before further use.

Notify your supervisor and lock out the crane until recertification is done.

HAND SIGNALS

Should you have a co-worker assist you, both of you should be aware of universal hand signals between you and your helper.



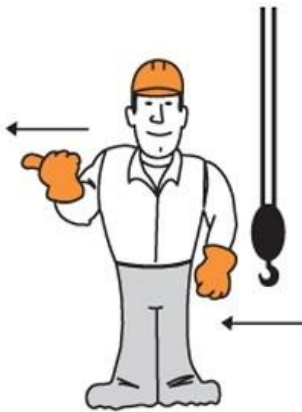
Hoist



Lower



Bridge Travel



Trolley Travel



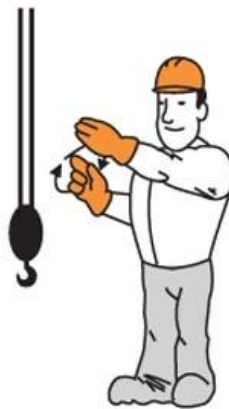
Stop



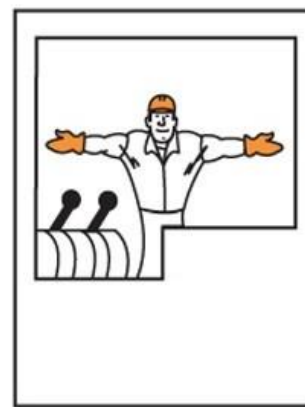
Emergency Stop



Use Trolley #2



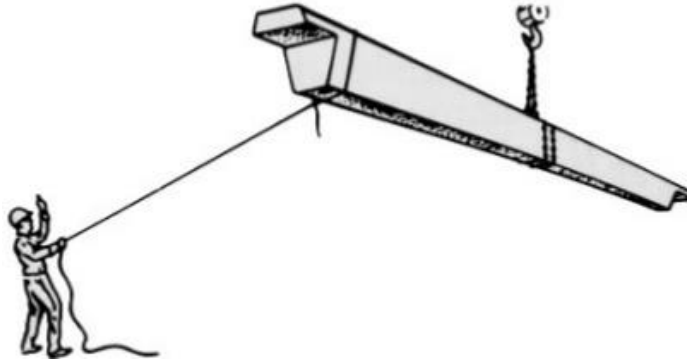
Hoist Slowly



Magnet Disconnected

TAGLINES

Any time you need to control the unintentional movement of a load, you must use a tag line.



Tagline Example

A tag line allows separation between the worker and the load.

Always maintain a safe distance from a suspended load and never place yourself in a pinch point.

Walk trailing behind the load where possible.

More on taglines will be discussed in “Rigging”.

PARKING

Do not leave the empty crane equipment in a position which may conflict with or get in the way of other activities. A dangling hook or pendant can easily get snagged on other equipment moving on the shop floor.

Upon completion of a lift, it is good practice to

- Move the trolley to one end of the bridge
- Retract the hoist to provide at least an eight foot clearance below the hook
 - Full retraction to the trolley is recommended
- Leave the pendant at one end of the bridge, close to the wall

FURTHER INFORMATION

ENGINEERING DESIGN REQUIREMENTS

All cranes must be manufactured, installed, and maintained according to regulations and standards. Any changes, modifications, etc. must be approved by a certified engineer.

CERTIFICATIONS

Crane components must meet certification standards. The bridge and supporting structure must meet CSA standards or equivalent. In addition, the electrical components must meet CSA standards and the Canadian Electrical Code.

CAPACITIES

All cranes have maximum capacities. The capacities of all parts of a crane must be matched. Capacities are marked on all major components (bridges, hoists, hooks, etc.).

A crane can only lift the maximum of the weakest component of the entire system. This includes all components of the crane and the rigging. Never overload a crane.

Any critical lifts should be preplanned and reviewed with your supervisor prior to making the lift. The critical lift plan must be filled out in its entirety before attempting to make the lift.

PRE-SHIFT SAFETY CHECKS

The operating procedures for a crane are either provided by the manufacturer or developed by the shop. Before operating a crane, make sure you read and understand TDM's *Safe Work Practice # 074 Overhead Cranes*.

Always complete the daily crane inspection log book. If any defects are noted, lock out the crane and notify your supervisor.

Never operate a defective crane.

BRIDGE SAFETY CHECKS

At the start of each shift do a visual check and an operations check. Here are the checks for bridge cranes:

- Visual Inspection for faults includes checking that:
- Travel areas are free and clear of obstructions.
- Wheels/trolley rollers are properly seated on the rails/beams.
- Conductors and collectors are free of debris.
- Festooned cables are running free and not tangled or damaged.
- Wire rope is neatly spooled on the drum.
- The hook is not sprung and the safety clip is in place.
- The control pendant or radio control is free of any damage.
- The main power shut-off switch is open, accessible, and turned on.
- There are no oil leaks or loose parts.
- Operations Check -when you do operation checks, listen for any unusual sounds from the crane. This is a signal that something may be seriously wrong with the equipment. (However, relying on hearing is not practical in high noise environments.) To do a check:
- Press each button on the control to make sure the crane does what the control indicates it will do.
- Check that any signal lights or signal horns are working properly.
- Check the brakes by moving the crane in a direction and releasing the button (see if the crane stops smoothly or coasts for a long way). However, when you're doing an operations check (and during normal crane operation), never run the crane into the end stops of the rails to stop it.
- Check the hoist limit switch by slowly raising the hook up until it trips the limit switch. If the limit switch is working properly, it will stop the hoist.
- Keep your eye on the crane hook while performing this test and never stand under the hook.
- If the upper limit switch fails, stop the hoist immediately. Do not allow the hoist to two block. Serious damage could result including breaking the hoist cable.
- Always perform this first test at slow speed.
- Afterward, lower the hoist block a couple of feet and try the limit switch at full speed, again keeping an eye on the hoist block.
- Stop the hoist if it goes beyond the point where it stopped at slow speed.
- Follow our lockout policy if any defects are noted.
- Do not allow yourself to become distracted by other workers. If you need to have a conversation with someone stop the lift.

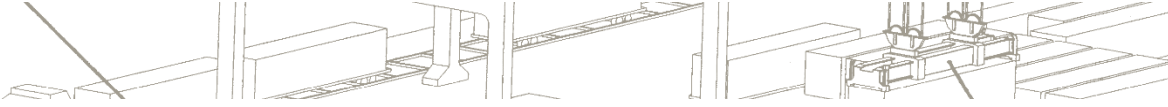


Limit switches are safety devices only.

They are not to be used as operational devices.

You must keep your eyes on the load at all times.

4 Rigging



THEORY

The purpose of rigging is to make sure the load is held safely while it is being moved. Take the time to make sure the rigging is right for the job.

CALCULATING WEIGHT

You need to know the weight of an object so that you can use the right capacity crane and rigging.

Overloading any component of a crane (sling, hook, hoist, etc.) can damage the crane or rigging and may result in a serious accident.

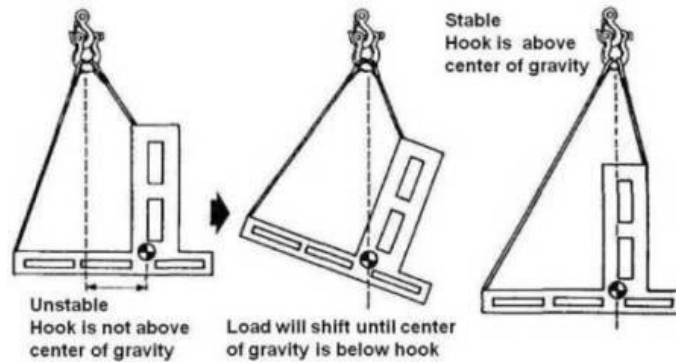
There are a variety of ways you can find the weight of an object:

- Check with experienced co-workers.
- Check bills of lading for material or equipment that has been delivered.
- Check drawings (blueprints).
- Calculation of weight may be possible for items such as a length of pipe, beam, or a steel plate if you know the weight per unit of length, area, or volume.
 - One square foot of steel plate one inch thick weighs almost 41 lbs.
 - 12 of these plates (or one cubic foot of steel) weigh 490 lbs.
 - If a pipe weighs 40 lbs. for one foot, then you can calculate its weight by multiplying the length by 40 lbs. For example, the calculation for a 10 foot length of pipe would be: 10 feet x 40 lbs./ft. = 400 lbs.
- Check weight charts or tables that have been written for common material.

CENTRE OF GRAVITY

It's also important to know the center of gravity of an object so loads can be rigged to stay balanced when they are lifted.

"Centre of gravity" is the point at which an object is balanced. For example, in a plate of steel, the center of gravity will be in the very center of the plate. In a fabricated metal frame, the center of gravity will be near to the heaviest parts of that frame.



Effect of Center of Gravity on a lift

Remember the center of gravity is not necessarily the center of the load. Many factors affect the center of gravity of any specific load, such as the placement of heavy motors, pumps and other equipment and material type, density, orientation and placement.

Determining the center of gravity is very important when using a single crane to make a lift. It becomes less of an issue when using two cranes - the load will remain balanced as long as both cranes lift at the same speed.



WARNING

Always ensure that the connection point of the rigging is higher than the center of gravity of the load.

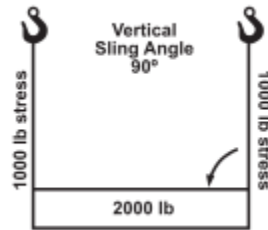
Large loads can flip over uncontrollably.

SLING TENSION

Tension is different from the load weight in that it is a specific measurement of how much stress is on a sling. They are both presented as a unit of weight (pounds, kilograms, tons, etc.)

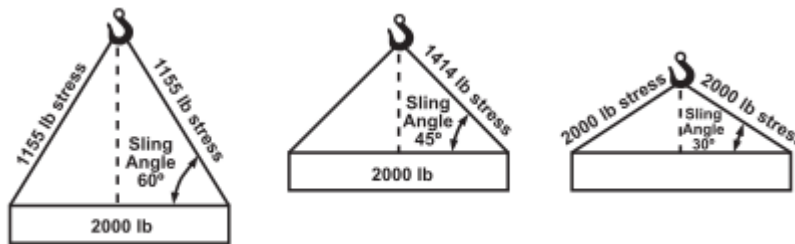
The only time the weight and tension are the same value is when a single sling is used to lift a load straight up. (A *vertical hitch*.)

Typically, two or more slings will be used to provide a more stable lift. If the slings are vertical, each one suspended from its own hook, the weight is evenly distributed. (A *basket hitch*.)



More typically, there will only be one hook to use therefore the slings will be at an angle. (A *bridle hitch*.) Angles less than 90 degrees increase the tension on the slings at varying rates depending on severity of the angles.

The smaller the angle between the load and the sling, the higher the tension (*stress*) on that sling.

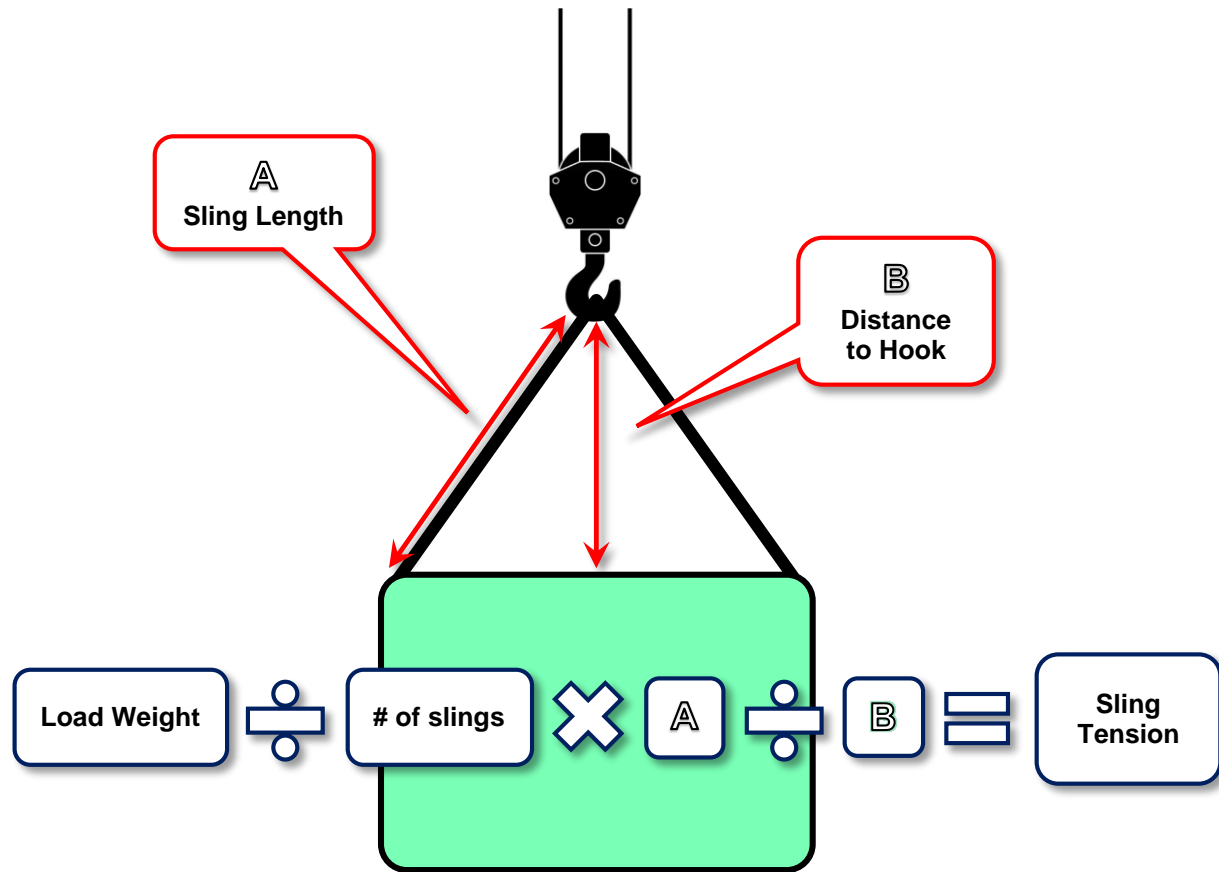


Because of the great stresses produced, sling angles should never be less than 30°, unless specifically approved by the sling manufacturer.

Added tension in a bridle angle makes edge softening even more important. Take necessary steps to soften edges for the slings.

TENSION CALCULATION

There are various methods of calculating sling tension. At TDM, we commonly use the following method.



Step	Notes
Establish the Load Weight	<i>Pounds, kilograms or tons</i>
Divide by the number of slings	<i>Minimum two (Formula works with a single sling but not useful because tension = Load Weight)</i>
Multiply by the sling length (A)	<i>Feet, inches, centimeters or meters Use the same units as (B)</i>
Divide by the vertical distance between the load and the hook	<i>Feet, inches, centimeters or meters Use the same units as (A)</i>
Equals the Tension on each sling	<i>The tension will be in the same units as the load weight</i>

When you have established the tension on each sling, ensure each one has an adequate safe working load limit (SWL or WLL).

Be aware that some slings will have additional considerations when in choker hitch configurations.

RIGGING HARDWARE

Hardware required for proper rigging includes eyebolts, rings, shackles and the slings themselves. A good rigger will choose the most appropriate hardware for the lift.

SLINGS & CHAINS

Rigging is the process of attaching the load to the crane hook. A range of different rigging equipment is used depending on the load shape, size, weight, and material. No matter what type of rigging you use, never use damaged rigging equipment.

WIRE ROPE SLINGS/CHOKERS



A wire rope sling is made from a length of wire rope, fitted with eyes at both ends. Before using a wire rope sling, check for kinks, corrosion, and broken wires. Pay close attention to connection points.

NYLON SLINGS

A nylon sling is a sling made out of a length of synthetic fibre fitted with eyes (or brackets) at both ends. There is a tag attached to the sling that indicates its capacity.



Inspect nylon slings for any sign of tears, holes, snags, abrasions, exposure to corrosive chemicals, burns, increased stiffness, knots, discoloration, or breaks in the stitching.

CHAIN SLINGS



A chain sling is a length of chain with a lifting ring and capacity tag on one end and hooks on the other. Chain slings are also manufactured as two-legged, three-legged, and four-legged chain slings. In these arrangements, one end of the chain is attached to a lifting ring and the free ends are equipped with hooks.

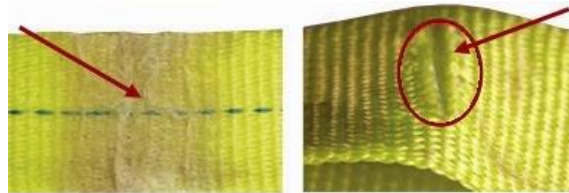
For inspection, first make sure the chain is clean. Check for marks, nicks, and wear. Inspect the links - look for twisted, bent, or stretched links. Check the bearing points (where one link meets another) for excessive wear. Also check for the manufacturer's tag that shows capacity.



The weight limit shown on the capacity tag of a set of chains is for a bridle angle of 60 degrees.

For all other angles, refer to the load charts posted on the shop walls.

DAMAGE TO RIGGING



Examples of damage to nylon slings

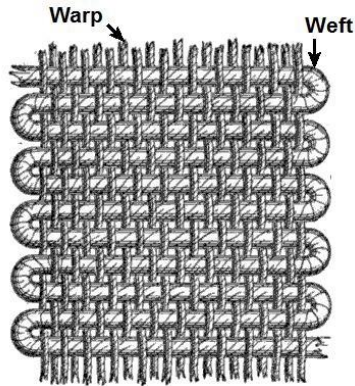
All rigging equipment including slings and attachments must be regularly inspected for any *nicks, scratches, cracks, abrasions, discolorations, corrosion, bends, twists*, etc. If you find damaged equipment, tag it, remove it from service, and notify your supervisor.

To avoid any damage to slings or other rigging equipment, care for and store them properly.

- Keep slings clean and never drag them along the ground.
- Do not kink or knot them.
- Keep them away from corrosives.
- When you finish using rigging equipment, place it in storage areas designed for this purpose such as racks or cabinets.

WARP WEAVING, SYNTHETIC FIBRE SLINGS.

From Wikipedia:



Warp and weft in plain weaving

STANDARD LIFTING DEVICES

Other attachments a variety of attachments are used for rigging including:

HOOKS



Chain slings always have hooks equipped with a safety latch to prevent the rigging from becoming dislodged.

CLAMPS

In metal fabricating, a common type of clamp is a plate clamp. This clamp is designed to grip the edges of metal plates for hoisting. The weight of the load itself acts as the gripping force, so the clamp cannot be removed from the load until it is at rest.

Always make sure the plate clamp jaws are in good repair. Never use a damaged plate clamp

There are four basic types of plate clamps in use in our shop.

VERTICAL PLATE CLAMPS



Vertical plate clamps are for vertical lifting only. This means that while the clamp can be fixed onto the plate while resting horizontally, the actual lift involves the plate being hoisted to a vertical stance.

These clamps are generally used one per plate.

The maximum capacity of the clamp is marked on the clamp body, both weight and thickness of the plate load.

A plate clamp has a maximum and a minimum capacity. The maximum capacity is marked on the clamp. The minimum capacity is calculated as 10% of the maximum. If you attempt a lift of less than 10% of the maximum, the clamp may not generate enough clamping force to hold the load securely.



Vertical plate clamps cannot be used in a bridal hitch. If more than one clamp is needed, use Universal plate clamp.

UNIVERSAL PLATE CLAMPS



Universal plate clamps work largely the same as Vertical plate clamps.

Universal clamps differ from vertical clamps in that they are designed to be used in a bridal hitch at an angle of 60deg's or higher, never go below an angle of 60 deg!

HORIZONTAL PLATE CLAMPS



Horizontal clamps are for use in lifting sheet plate in the horizontal position. They must be used in pairs *directly opposite and facing each other*.

- Do not side load and do not combine bridle hitches such that side loading would occur.
- When using more than one pair of horizontal plate clamps, always use two cranes or a spreader bar.
- The capacity marked on the plate clamps is the capacity for both clamps together.

TSCC SCREW TYPE LIFTING CLAMPS



Screw-Type clamps are designed to lift a variety of shapes and configurations up to their maximum capacity.

The screw is fitted with a spindle pivot and a cam. On tightening the spindle, there will be constant pressure on the pivot and cam. The clamp therefore cannot slip upon taking up the load.

When lifting the load, the clamping strength of the clamp is increased by the weight of the load and the angle of the cam. Also when depositing a load, the clamp cannot spontaneously let go.

Always refer to the operator's manual and the safe work practice for more information before using this or any other clamp.

BEAM LIFTING CLAMPS



Beam lifting clamps hook under opposing sides of a beam, with notches for the edges.

SHACKLES

Shackles are the primary connecting link in all manner of rigging systems, as they allow different rigging systems to be connected or disconnected quickly.

Shackles come in a variety of shapes and sizes. Any shackle used in any hoisting operation must be designed and certified for that purpose. All the required information must be embossed on the shackle and clearly legible

SCREW PIN SHACKLE



This is the most common type of shackle used in rigging in our shops. They come in different grades and capacities and must have all the required information marked on them to clearly identify the grade and capacity.

When inserting the pin in a screw pin shackle put the pin hand tight and leave it, do not back it off and do not use a wrench or other tool to tighten it.

BOLT TYPE SHACKLE



A bolt type of shackle consists of a shackle body and a bolt and nut. The bolt has a hole in the threaded end to accommodate a cotter pin, when in use this cotter pin must be in place.

Those shackles are used mainly for rigging that's for a permanent set up and the cotter pin will keep the nut from coming off.

SLING SHACKLES



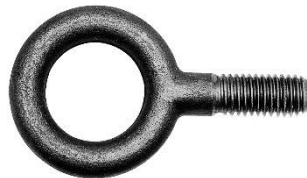
Sling shackles are designed with a more flat shaped type body to allow the sling to sit flat on the shackle body.

EYEBOLTS

An eye bolt is a bolt with an eye at the end for attaching a shackle.

Eye bolts come in a variety of shapes and sizes and are designed for specific purposes.

NON SHOULDERED THREADED EYE BOLTS



Before using, ensure that the eye bolt is certified for use in a hoisting operation and marked accordingly.

Non-shouldered eye bolts are for vertical lifting only and must never be used in a side pull.

When the eye bolt is treaded into the material, the threads must be inserted to a depth of one and one half times the diameter of the bolt.

If the hole in the material is not threaded, a nut and washer must be placed on both sides of the material and tightened securely.

SHOULDERED EYE BOLTS



Shouldered eye bolts can be used in a bridal hitch as per manufacturer's specifications.

The eye bolt must be threaded into a threaded hole to a depth of one and one half times the diameter of the bolt. They must be fully seated on the shoulder and torqued to specs.

Any side pull must be made in line with the bolt to prevent damaging the eye bolt. The capacity of the eye bolt will be reduced when the eye bolt is side loaded.

SWIVEL HEAD OR SELF-ALIGNING EYE BOLTS



These eye bolts self-align in the direction of the pull.

They can only lift their rated capacity in a vertical direction (90 degree angle). Refer to manufacturer's instructions for lifting capacities in other directions.

MAGNETIC LIFTING TOOLS

TDM has several different magnets in our shop.

The largest magnets are the battery powered ones used at the burn table.



Battery powered lift Permanent magnet lift

The other magnets are of the permanent magnet design. Regardless of the power supply all magnets have the same basic operating limitations.

Magnets are vertical lifting devices only and must never be used in a bridal hitch.

Before using any magnet for the first time the worker must be trained in its safe use. This includes reading the operator's manual and the safe work practice for the magnet.

This training must be documented on the QF-32 Training form and signed by the worker and the competent instructor who trained the worker. These forms must be submitted to the HSE Dept and a copy will be placed in the workers training file and also in the workers HR file.

A magnet can only lift its rated capacity if the material is of sufficient thickness to allow the maximum magnetic lines of force to pass through the material.

Magnets are tested on a polished piece of flat steel 1¼ inches thick. If a magnet has a rated capacity of 2200 lbs. at that thickness, it will only have a capacity of 90 lbs. on a piece of steel ¼ inch thick.

Never attempt to lift material thinner than ¼ inch with a magnet. Other factors that affect a magnet's capacity are, *temperature, rust, paint, weld spatter, burrs* and anything else that creates an air gap between the mating surfaces of the magnet and the load.

Never lift any long flat material like flat bar that could bend and peel away from the magnet.



WARNING

ALWAYS READ THE SAFE WORK PRACTICE FOR THE MAGNET YOU WILL BE USING FOR THE FIRST TIME.

"HOME-MADE" LIFTING DEVICES

Do not use these unless they are certified by an engineer.

OTHER LIFTING TOOLS

SPREADER BARS



A spreader bar is a length of metal tubing with a smaller tubing inside. The length is adjustable by removing the pin and either extending or retracting the inner tube and replacing the pin.

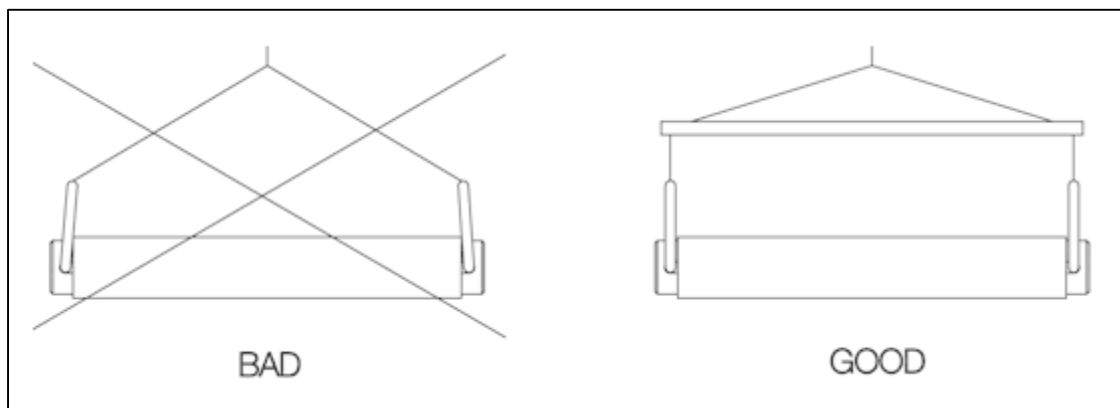
The longer the spreader bar, the less capacity it has. Refer to the capacity tag on the spreader bar for the different capacities.

Spreader bars must be designed and approved by a certified engineer and must have a capacity plate permanently attached with the required information.

LIFTING BEAMS



A Lifting Beam (also known as an I Beam spreader bar) is a length of I-beam that has its maximum capacity marked on the capacity plate. A lifting beam allows the rigging to be used in a vertical configuration. It also allows the use of multiple hoists to lift a heavy load without the risk of overloading the cranes.



Lifting beams must be designed and approved by a certified engineer.

COME-A-LONG AND CHAIN FALL

A **Come-a-Long** is a hand operated winch with a brake used to pull objects.

- If the label on the handle says “*Lever Puller*”, the device cannot be used for hoisting. It only has a single brake and may not hold a load securely.
- If, however, the device is labelled “*Lever Hoist*”, it can be used for hoisting operations because it has a double brake mechanism.
- The body of a come a long must not be in contact with any object or supporting structure.
- The hoist chain must not be used as a sling or wrapped around the load.
- Never use a snipe (piece of pipe) to gain extra leverage.
 - The device can reach its maximum capacity with a 75 lb. pull on the handle.

A **Chain Fall** operates on the same principle except it uses an endless loop of chain instead of a handle.

As with a Come-a-Long, a 75 pound pull on a Chain Fall will generate enough force to allow it to lift its maximum capacity. Do not overload.



Come-a-Long Chain Fall

ADJUST-A-FIT



This unusual tool is very useful for suspending piping fittings in place for welding.

HITCHING METHODS

A hitch is the technique for using a sling to attach a load to the crane hook. There are a variety of hitches, both simple and complex. Here are four basic hitches.

VERTICAL HITCH

Sometimes called a "single leg hitch," this is the simplest form of rigging. It consists of attaching a single sling to a fixed lifting point (such as an eyebolt or shackle) on a piece of equipment/material and attaching the other end to the crane hook.

A vertical hitch is used to lift any item which can be safely lifted by attaching to a single existing lifting point.

Example: to lift an electric motor with a manufactured eyebolt designed to lift this piece of equipment.

Make sure the sling and any other equipment such as hooks or shackles all have a sufficient capacity rating for the load.



CHOKER HITCH

With a choker hitch, the sling is placed around the material being lifted.

The sling is pulled through one eye or fitting on the sling so it draws tight around the material. The second eye is attached to the crane hook.

A single choker hitch is used to lift items such as a short beam or short piece of pipe. It is wrapped around the item, drawn tight, and attached to the crane hook.



Note:



When using nylon slings, the end with the tag always goes on the hook.

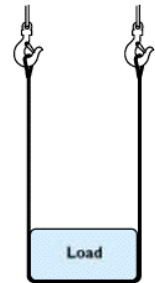
Never choke on the tag end, otherwise, damage to the tag can result.

For longer beams or pipes use two slings attached to the item using **double wrap choker** hitches. These slings are attached an equal distance from the center of the pipe or beam. The free ends of the chokers are attached to the crane hook.

BASKET HITCH

A true basket hitch is formed when a sling is placed under a piece of material and both eyes are attached vertically to two independent hooks. This forms a "basket" under the material.

A basket hitch is used for loads whose shapes lend themselves to being lifted by looping the sling under a part of the object where balancing or gripping is not a concern. For example, the basket hitch would be used for a vessel laying on its side or a similar horizontal object being lifted.



MODIFIED BASKET HITCH

When both ends of the sling are attached to the same hook or shackle, you have created a modified basket hitch. This is not a true basket hitch, although it's often called that.

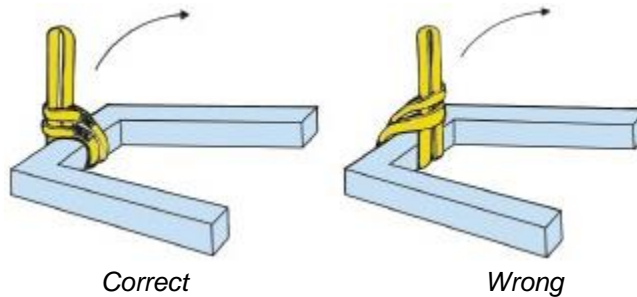
A modified basket hitch has the same capacity as a choker hitch.



TURNING HITCH

“Turning” a load involves inverting or flipping the item and requires special attention to the hitch method. A turning hitch is used to prevent a load from slipping around on the rigging as it turns over.

Always use a turning hitch when turning a load. Place sling eyes on top of the load, pointing the opposite direction of the turn.



Depending on the object being turned it may be necessary to reposition the rigging half way through the turn in order to enable the load to complete the turn.

BRIDLE HITCH



A bridle hitch is an arrangement with two, three, or four single hitches that are attached to lifting points on the load and to the crane hook.

LIFT EXECUTION

One of the most important pieces of information you must know before operating any overhead crane is the location of the main power switch. If something goes wrong, you need to react quickly.

Secondly you need to know the weight of the load so you can choose the correct rigging.

Always prepare the landing place before picking up the load.

Ensure the crane has passed its pre use inspection and it's in good operating condition.

Ensure that the rigging you will be using has been inspected and is free of defects.

Determine if a tag line will be necessary.

For any lifts that exceed 75% of the crane's lifting capacity, ENSURE THAT A CRITICAL LIFT PLAN IS FILLED OUT AND SUBMITTED to the HSE Department.

RIG THE LOAD

Plan the rigging by establishing:

- What does the load weigh?
- What shape issues must be considered?
- Does size create a potential problem?
- Where is the center of gravity?
- Can the rigging damage the load?
- Can the load damage the rigging?
- Is a tag line required?

The steps:

1. Select the right rigging.
 - a. Establish the load characteristics (weight, orientation, center of gravity, etc.)
 - b. Consult the appropriate Load Charts.

Attach the rigging to the load.

- c. Use various hitches or attachments (i.e. hooks, shackles, eyebolts, etc.).

Attach the rigging to the crane hook.

Before lifting, do a final check:

- d. Check the angles of the slings to see if the sling capacity at these angles is right for the load (refer to load charts).
- e. Check all slings to make sure there are no knots or kinks in them.
- f. Check to see if any of the slings might be damaged by sharp edges on the load.
- g. Make sure the safety clip is keeping the rigging safely on the crane hook.


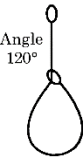
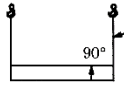
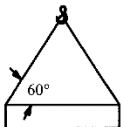
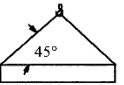
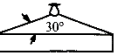
READING A LOAD CHART

A load chart, sometimes called a capacity chart, lets you know how much weight a hitch can lift. There are charts for each type of sling (i.e. chain, wire rope, nylon, etc.) posted in the facility. Weight capacities are based on sling size and type of hitch.

When slings are used at angles, the capacity varies with the angles. The capacity tag on a set of chain slings give you the capacity for those chains in **a bridal hitch at 60 deg's**, for any other angle always refer to the load charts for the rigging you are using.

The further apart the slings are on the load, the less the slings can lift. This is why load charts are critical.

LOAD CHART - WIRE ROPE


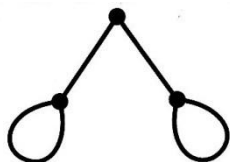
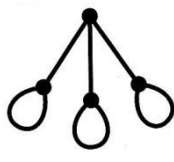

Wire Rope Sling Capacities (lbs.) – Flemish Eye – ANSI B30.9						
6 x 19 and 6 x 37 Improved Plow Steel - IWRC 5/1 Design Factor						
Wire Rope Diameter (Inches)						
	Vertical	Choker	Two Leg	60 Degree Sling Angle	45 Degree Sling Angle	30 Degree Sling Angle
1/4	1120	820	2200	1940	1500	1100
5/16	1740	1280	3400	3000	2400	1700
3/8	2400	1840	4800	4200	3400	2400
7/16	3400	2400	6800	5800	4800	3400
1/2	4400	3200	8800	7600	6200	4400
9/16	5600	4000	11200	9600	7900	5600
5/8	6800	5000	13600	11800	9600	6800
3/4	9800	7200	19600	16900	13800	9800
7/8	13200	9600	26400	22800	18600	13200
1	17000	12600	34000	30000	24000	17000
1 1/8	20000	15800	40000	34600	28300	20000
1 1/4	26000	19400	52000	45000	36700	26000
1 3/8	30000	24000	60000	52000	42400	30000
Rated capacities based on pin diameter no larger than the natural eye width or less than the nominal sling diameter.						
Refer to ANSI B30.9 for full details.						
Horizontal sling angles of less than 30 degrees are not recommended.						

Remember that you must use the load chart for the specific type of sling you have.

LOAD CHART – CHAIN SLING / CHOKER HITCHES

From ASME B30.9-2010

Table 9-1.5.4-1 Rated Load for Grade 80 Alloy Steel Chain Slings — Choker Hitches


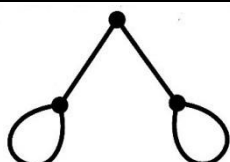
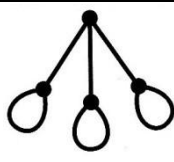
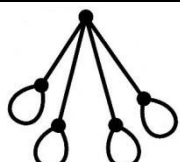
		Single-Leg Vertical Slings	Double-Leg Bridle Slings				Triple- and Quadruple-Leg Bridle Slings		
									
Nominal Chain Size		Nominal Horizontal Angle, deg [Note (1)]							
		90	60	45	30	60	45	30	
in.	mm	lb	lb	lb	lb	lb	lb	lb	
$\frac{7}{32}$	5.5	1,700	2,900	2,400	1,700	4,400	3,500	2,600	
$\frac{9}{32}$	7	2,800	5,000	3,900	2,800	7,300	5,900	4,200	
$\frac{7}{16}$	8	3,600	6,200	5,100	3,600	9,300	7,600	5,400	
$\frac{3}{8}$	10	5,700	9,800	8,000	5,700	14,700	12,100	8,500	
$\frac{1}{2}$	13	9,600	16,600	13,600	9,600	25,000	20,400	14,400	
$\frac{5}{8}$	16	14,500	25,000	20,500	14,500	37,600	30,700	21,700	
$\frac{3}{4}$	20	22,600	39,200	32,000	22,600	58,800	48,000	33,900	
$\frac{7}{8}$	22	27,400	47,400	38,700	27,400	71,100	58,000	41,000	
1	26	38,200	66,100	53,900	38,200	99,100	81,000	57,200	
$1\frac{1}{4}$	32	57,800	100,200	81,800	57,800	150,200	122,700	86,700	

GENERAL NOTE: Rated loads are for angles of choke greater than 120 deg [see Fig. 9-1.0-1, illustration (e) and para. 9-1.5.5].

NOTE:

(1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane of the load [see Fig. 9-1.0-1, illustration (d)].

Table 9-1.5.4-2 Rated Load for Grade 100 Alloy Steel Chain Slings — Choker Hitches

		Single-Leg Vertical Slings	Double-Leg Bridle Slings				Triple- and Quadruple-Leg Bridle Slings		
									
Nominal Chain Size		Nominal Horizontal Angle, deg [Note (1)]							
		90	60	45	30	60	45	30	
in.	mm	lb	lb	lb	lb	lb	lb	lb	
$\frac{7}{32}$	5.5	2,100	3,600	3,000	2,100	5,500	4,400	3,200	
$\frac{9}{32}$	7	3,500	6,100	4,900	3,500	9,100	7,400	5,200	
$\frac{7}{16}$	8	4,500	7,800	6,400	4,500	11,700	9,500	6,800	
$\frac{3}{8}$	10	7,100	12,300	10,000	7,100	18,400	15,100	10,600	
$\frac{1}{2}$	13	12,000	20,800	17,000	12,000	31,200	25,500	18,000	
$\frac{5}{8}$	16	18,100	31,300	25,600	18,100	47,000	38,400	27,100	
$\frac{3}{4}$	20	28,300	49,000	40,000	28,300	73,500	60,000	42,400	
$\frac{7}{8}$	22	34,200	59,200	48,400	34,200	88,900	72,500	51,300	

GENERAL NOTE: Rated loads are for angles of choke greater than 120 deg [see Fig. 9-1.0-1, illustration (e) and para. 9-1.5.5].

NOTE:

(1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane of the load [see Fig. 9-1.0-1, illustration (d)].

DEALING WITH PROBLEMS

Even with well-maintained cranes and trained operators, problems can occur while a lift is in progress. The key in all cases is to contact a supervisor or experienced operator as soon as possible when a problem occurs.

Some examples of problems and suggested actions are:

- Failure of controls to operate properly during a check
 - For a pendant control failure, tag out the crane and notify the supervisor.
- Runaways and frozen controls
 - If a crane starts moving on its own or fails to respond to pendant buttons, push the emergency stop button on the pendant
 - If this does not stop the crane, shut off the power at the main power switch located on the shop wall,
 - If the load is left suspended, barricade off the area.
- Brake failure or malfunction
 - If the brakes fail to operate during a pre-shift safety check, stop the work and lockout/tag out the crane.
 - Do not operate the crane until the brake malfunction has been repaired.
 - If the brakes fail while moving or hoisting a load put the load back down and lock out the crane, notify your supervisor.
- Electrical malfunction
 - Follow lockout policy and notify your supervisor.
- Derailment
 - Should a bridge or trolley come off its rails, lower the load if safe to do so
 - If the load cannot be placed on the floor safely, lockout the crane and barricade the area.
 - Notify your supervisor and the HSE Dept so an investigation can be started immediately.
 - Do not try to get the equipment back on the tracks by yourself. Leave that to certified maintenance people.
- Failure of any part of the hoist or rigging that results in the load being dropped
 - Stop all activity.
 - Press the emergency stop button, lockout the crane.
 - Leave everything as it is including the area of collision if applicable.
 - (The exception to this rule is to administer aid to personnel as necessary.)
 - Barricade the area.
 - Notify your supervisor who will arrange for a proper investigation and notify authorities as required.

In all cases of problems or failures with cranes, lockout/tag out the crane pendant.

5 The Shop

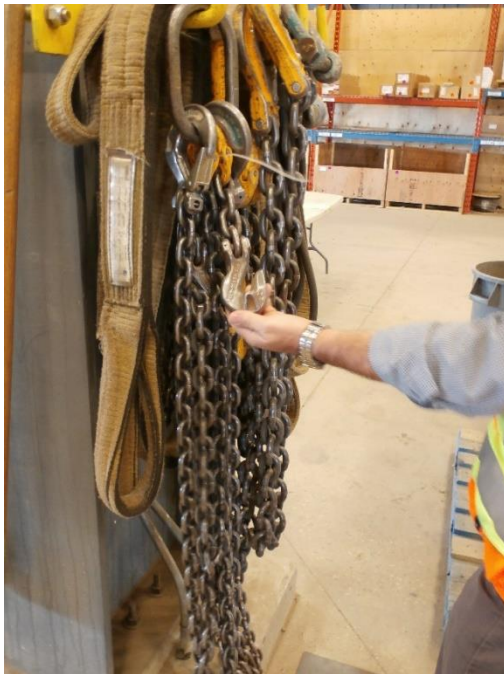
RIGGING TOUR



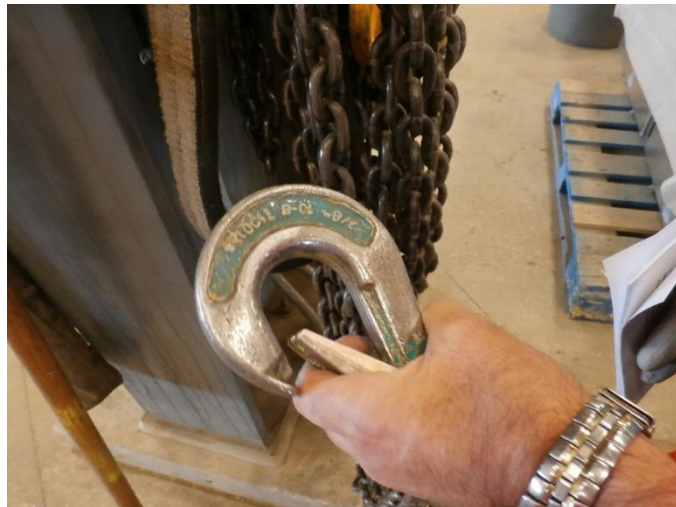
Round sling



Web slings



Chain slings



Hook with safety latch



Stored Shackles



Adjust-A-Fit



TSCC Screw-Type clamp



Horizontal Plate clamp



Beam-lifting clamp



Vertical plate clamp



Universal plate clamp



Small LOTO pendant bag



Large LOTO pendant bag



Crane power switches



Two-crane moves

6 Reference




WEIGHTS OF COMMON MATERIALS

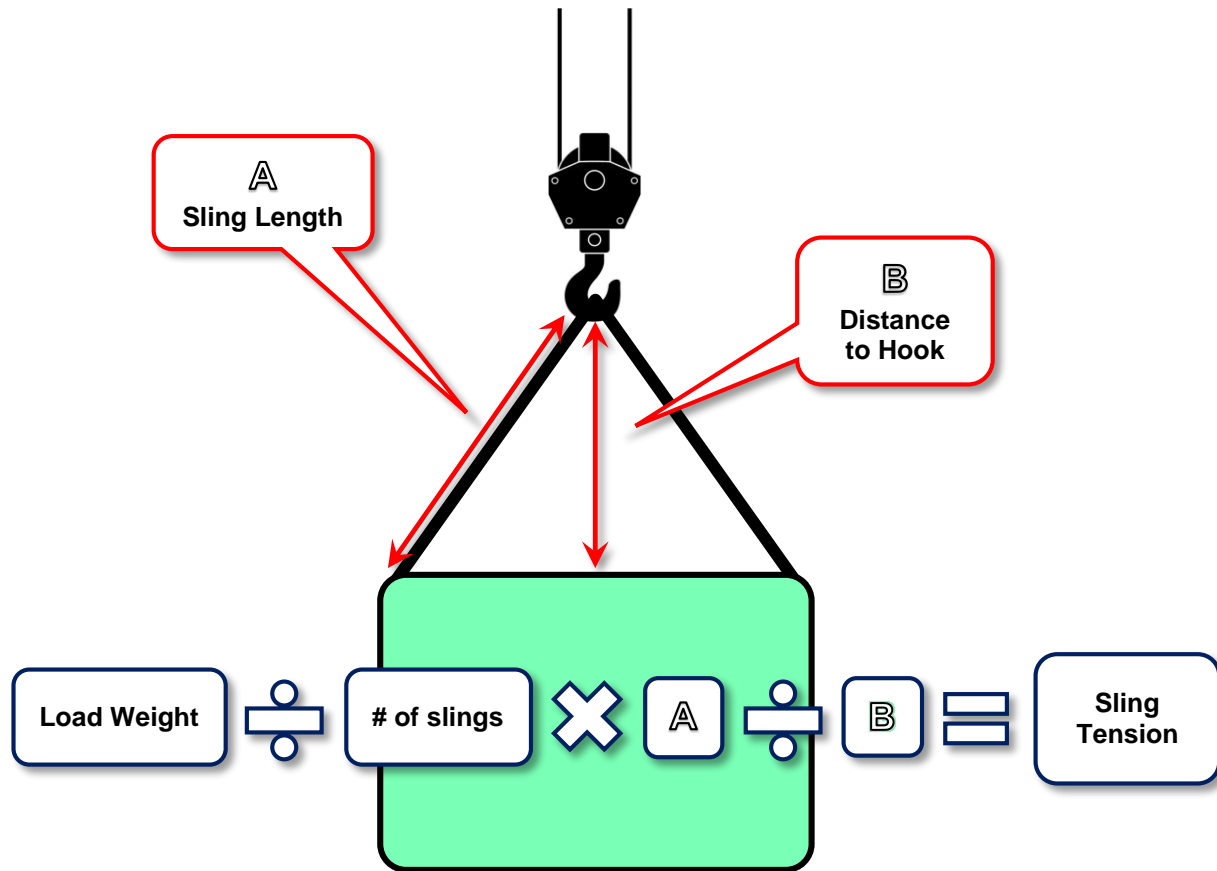
Name of Metal Weight	(lb/ft ³)
Aluminum	166
Antimony	418
Bismuth	613
Brass, cast	504
Brass, rolled	523
Brick, common	125
Brick, pressed	150
Cement, Portland (loose)	70-90
Cement, Portland (packed)	100-120
Cement, slag (loose)	55-75
Cement, slag (packed)	80-100
Cinder concrete	110
Clay, ordinary	120-150
Concrete or stone	140-155
Copper, cast	550
Copper, rolled	555

Name of Metal Weight	(lb/ft ³)
Earth, rammed	90-100
Gold, 24-carat	1,204
Granite	165-170
Gravel	117-125
Iron, Cast	450
Iron, wrought	480
Lead, commercial	712
Lime, quick (ground loose)	53
Limestone	170
Silver	655
Slate	160-180
Steel	490
Tin, cast	458
Uranium	1,163
Water	65
Zinc	437

CRITICAL LIFT PLAN - FORM 070

	<p>Nisku, Alberta www.trinidadrilling.com</p>
Critical Lift Plan	
<p>Date: _____ Shop #: _____</p> <p>Item being lifted: _____ Weight: _____</p> <p>How was the item weight determined: _____</p>	<p>This form must be used anytime the load exceeds 75% of cranes capacity.</p> <ul style="list-style-type: none"> •All employees involved in a critical lift must be wearing the mandatory PPE. •The critical lift shall be performed by competent, trained, and experienced employees. •Before the critical lift occurs, the lead hand/foreman shall hold a meeting to advise all involved of where, when, and why the lift will be occurring. All hazards related to hoisting operations must be addressed and controlled prior to and during the lift. •Ensure the proper tag lines are used and are used appropriately as per SWP #074. Non- conductive tag lines must be used. •The lead hand/foreman will designate employees to flag off and/or barricade the area of the lift. This employee will also communicate the lift and possible hazards to other workers in the vicinity. •Ensure the load is free, the hooks are properly engaged, and the rigging is gradually tightened before lifting occurs. •Loads are never to be moved over personnel. •While travelling, keep the load as close to the ground as possible until you reach your destination where the load can be raised. •Never leave a load suspended. While the load is suspended, make sure the hoist or crane is attended at all times. If the hoist or crane must be left unattended for any reason, secure the load, barricade the area and lock out the controls. •Non-essential employees are not to be in the vicinity of the lift until the load is secured.
<p>Who did the calculations: _____</p> <p>Person in charge of lift: _____</p> <p>Rigging inspected by: _____</p> <p>Proper tag line determined: <input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Softeners required for sharp edges: <input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Crane log book up to date: <input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Cranes inspected by: _____</p> <p>Signal person: _____</p> <p>How will lift area be barricaded: _____</p>	<p>Once the load has been secured and the barricades are removed, non-essential workers can return to their work sites within the lift zone.</p> <ul style="list-style-type: none"> •Return all rigging to the proper storage area. Inspect rigging for damage and wear before storing; tag out if applicable.
<p>Lift plan approved by: _____</p> <p>Attendees</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	

SLING TENSION CALCULATION



Step	Notes
Establish the Load Weight	<i>Pounds, kilograms or tons</i>
Divide by the number of slings	<i>Minimum two (Formula works with a single sling but not useful because tension = Load Weight)</i>
Multiply by the sling length (A)	<i>Feet, inches, centimeters or meters Use the same units as (B)</i>
Divide by the vertical distance between the load and the hook	<i>Feet, inches, centimeters or meters Use the same units as (A)</i>
Equals the Tension on each sling	<i>The tension will be in the same units as the load weight</i>

OVERHEAD CRANE SAFE WORK PRACTICES

From SWP-074 Rev 5

- Keep the area free of debris to prevent slips, trips, and falls.
- All personnel operating the cranes must have adequate training and experience.
- New or inexperienced workers must be deemed competent by their supervisor before they can operate the crane unsupervised. The worker must read the SWP and the training must be documented on the QF-32 form, once the worker is deemed competent a completed copy of this form must be submitted to the HSE dept and it will be placed on the workers file.
- A logbook must be kept for each crane detailing the inspections, tests, checks, any defects, repairs, changes, modifications, accidents involving the crane, and engineering certification information. All entries must have the date, time, and the person doing the record.
- At the start of each shift, a visual and operational check must be done. This must be documented.
- Inspect the spreader bar, hooks, safety latches, and slings prior to each lift. All damaged equipment must be removed from service and reported to the shop supervisor.
- If the load exceeds 75% of the cranes capacity you must fill out a critical lift plan, those will be kept on file by the HSE Dept.
- The crane is for vertical lifting only, never side load a crane. Start and stop the lift slowly to avoid shock loading the crane, if the rigging breaks during a heavy lift this can severely shock load the crane.
- Use a tag line of sufficient length to control the load if necessary, do not place your hands on the load or the rigging. Stand clear and have a helper control the load with the tag line if necessary.
- Raise the load only as high as necessary to clear obstructions, always warn other workers in the vicinity of the lift to move a safe distance from the area while moving the load through a work area.
- Overloading any component of the crane can damage the crane or cause a serious accident; therefore, it is critical to know the weight of the load.
- Plan and check the travel route in advance. Ensure the route is clear and does not pass over workers.
- Roping or barricading may be needed for large or complex moves.
- Whenever possible walk in the direction of travel following the load to avoid tripping hazards and pinch points.
- Always keep both hands on the crane pendant to maintain control, if you need help ask another worker.
- Never throw a pendant of a structure as this can cause damage to the cables or allow the pendant to swing striking another structure. This could cause the pendant buttons to become damaged, a runaway crane could be the result.
- Do not place the load on top of the rigging, use suitable blocks to protect the rigging from getting damaged.
- After the move, park the crane and raise the hook so that it is safely above workers.
- If the crane is equipped with two trolleys on a bridge and you are only using one hoist ,all the rigging must be removed from the unused hoist and the hook placed in the full up position.
- Do not attempt to lift when either hook or load is swinging.
- Ensure you know the correct hand signals.
- Do not leave a suspended load unattended.
- If electric power goes off, push the emergency stop button until power has been restored. Barricade the area if a load is suspended.
- Do not wear heavy gloves when operating the crane, Gloves must be light enough to allow the operator to feel the pendant buttons.
- During big lifts the workers involved should not be wearing a respirator in case they need to yell out warnings or instructions to other workers.

LOCK OUT / TAG OUT PROCEDURE

From SWP-047 Rev 4

The person(s) responsible for servicing or repairing equipment shall:

- Disconnect and tag the power supply.
- If the controls to the machine are designed to accept a padlock, these controls must be locked out.
- In the event that the padlock cannot be used, a tag with the wording "THIS UNIT SHALL NOT BE USED OR MOVED" must be put in place or the machinery must be rendered inoperative in a manner that will prevent accidental startup and will provide for equal or greater protection than the previously specified points.
- Each person performing repairs to equipment shall be responsible for installing and removing their own locks or tags.
- Only the person whose name appears on the tag can render the unit fit to operate
- Tags shall be made of material that does not conduct electricity. Tags shall contain the following information: Words directing persons not to start the machine, the date the equipment was tagged, and the name of the person working on the machine.

LIFTING MAGNET PML 10

From SWP 092 (Rev 1)

- Before using this magnet for the first time, the worker must read and understand the operator's manual.
- Read the safe work practice and ensure it gets documented on the QF-32 training form.
- Inspect the magnet for any signs of damage before using.
- This magnet weighs 50 KG, do not attempt to carry this magnet by yourself, always ask for help.
- Always ensure that the face of the magnet is clean and smooth before attempting a lift.
- Ensure the piece to be lifted is free of paint, Rust and welding Spatter and anything that would create an air gap between the face of the magnet and the load.
- Never lift a load over other workers and keep a safe distance from the load at all times.
- The magnet is for vertical lifting only, always ensure that the load is level before picking it off the surface, readjust as required.
- Do not use a magnet in a bridal hitch.
- Never subject a magnet to Shock, Bumps or sharp blows.
- Lift only one piece at a time.
- Do not lift anything that could bend and peel away from the magnet, EG. (Flat bar or Thin plate.)
- The magnet can only lift its rated capacity on clean mild steel at least 50 mm thick. Refer to the capacity chart in the operator's manual for other thicknesses.
- Never allow any part of your body to come between the magnet and the load.
- Always store the magnet in the off position.
- Do not release the load until it is sitting on a firm surface and all the load is off the rigging.
- Do not modify the magnet in any way.
- Do not lift any load above 80 degrees C or below -40 C.
- The magnets capacity will be reduced by 50% when lifting round bar.
- When finished with the magnet, always inspect it for damage before storing it and tag out the magnet if it fails inspection.

LIFTING MAGNET RPL 22

From *SWP 026 (Rev 2)*

- Always read the owner's manual and the SWP before using the RPL-22 Magnet. The owner's manual is located in the tool crib.
- Always perform a pre-use inspection of the RPL-22 Magnet before using it, do not use a defective magnet. Tag it out and notify your supervisor and write a Hazard ID.
- Load thickness affects capacity, the thinner the metal the less weight the magnet can lift, the magnet was tested on 1 ¼" polished low carbon steel, at ¼ in thickness the magnet can only lift 90 lbs. Do not attempt to lift anything thinner than ¼ in.
- Inspect the surface of the material to be lifted for anything that could prevent full contact of the magnet, IE; weld spatter, Rust, Paint, Burrs, or anything that creates an air gap will reduce lifting capacity.
- Maximum temperature of the metal to be lifted should not exceed 80C or 175F, Temperature affects capacity by changing the magnetic characteristics of the metal.
- Always place the magnet on top of the load before turning it on, test lift the load a few inches to ensure it is level, only carry level loads.
- Always maintain a safe distance from the load and yourself and others, never carry a load over other workers.
- Do not release the magnet while the load is suspended.
- Do not allow the load to come into contact with obstructions.
- Do not exceed the maximum capacity of the magnet.
- Do not lift more than one piece at a time.
- Do not lift materials that could bend and peel away from the magnet. IE Flat bar?
- Do not allow the load to swing, use proper crane techniques.
- When not in use store the magnet in the off position in a secure location.
- Never hammer near a magnet, the shock from a sharp blow can cause a magnet to lose its magnetism.
- Any workers wearing a pace maker should consult with their doctors before using a magnet
- Use extreme caution when using the magnet to lift parts off a metal work bench, the magnet may try to lift the work bench as well causing the piece you are trying to lift to fly up violently causing injuries...

MAN BASKETS

From *SWP 073 (Rev 3)*

- Man baskets are to meet government regulations.
- Any modified or company engineered man baskets must be certified by an engineer and the approval plate must be welded on in a visible location.
- Workers using a conventional man basket must use a full body harness with a lanyard secured to the basket. The basket must be secured to the load line above the anchor point.
- Never exceed the maximum load limit.
- Tools and equipment in the man basket must be kept to a minimum.
- No more than two persons shall be allowed in any man basket at one time.
- Man baskets must be inspected for cracks or deterioration prior to use.

HOISTING

From SWP 009 rev 4

- Only trained competent workers are to perform any hoisting operations.
- A pre use inspection must be performed on each overhead crane and documented in the Dailey crane inspection book at the start of each shift.
- Determine the weight of the load prior to making a lift and ensure that all components are of adequate capacity to perform the lift safely.
- Estimate the center of gravity or point of balance. The lifting device should be positioned immediately above the estimated center of gravity.
- Always prepare a landing place before picking up the load, do not put yourself in the position to have to leave the load suspended while you prepare the landing spot. Lower the load gently and make sure it is stable before slackening the sling or chain.
- Never place the load on top of the rigging, use blocking of adequate capacity to place the load on.
- Select only **Grade 80 or higher** chain slings and never exceed the working load limits.
- The **capacity tag** on the crane chains gives you the capacity of that set of chains in a **60 deg's bridal hitch**, for all other capacities at different angles and configurations refer to the **load charts**.
- Make sure the hoist or crane is directly over the load.
- Use slings of proper reach. Never shorten a sling by twisting or knotting. With chain slings, never use bolts or nuts.
- Never permit anyone to ride the lifting hook or the load.
- Make sure all personnel stand clear from the load being lifted.
- Never work under a suspended load, unless the load is properly supported.
- Never leave a load suspended when the hoist or crane is unattended.
- Inspect all slings thoroughly before every use, make sure they are in good condition. Remove any rigging that fails inspection and either repair or replace, follow **Tag out** policy.
- Inspect each chain or sling for cuts, nicks, bent links, bent hooks, etc., before each use. If in doubt, don't use it.
- Ensure that safety latches on hooks are in good working condition.
- Ensure that the signaler is properly identified and understands proper signaling.
- Make sure a tagline is used if you need to control the load. Always keep a safe distance from the load.

CABLE CLIPS & WIRE ROPE CLAMPS

From SWP 037 (Rev 3)

- Be sure to wear proper PPE such as gloves, glasses, hard hat, work boots, etc.
- Persons installing cable clamps must be trained in the proper procedure. Improperly installed clamps could fail causing property damage, injury, or death.
- Clamps must be installed with the U-bolt on the dead end.
- The proper number of clamps and the spacing of the clamps must be correct. The clamps must be spaced no more than 6 times the diameter of the wire rope. The first clamps should be one base length from the dead end of the rope.
- Torque nuts on the first clamp to the recommended torque. Refer to manufacturers' spec charts for proper torque.
- Install the second clamp as close to the loop as possible; do not torque nuts yet.
- Install the remainder of the clamps at the correct spacing; do not torque nuts yet.
- Apply tension to the cable and loop. Starting at the first clamp, torque the nuts to specifications. Continue working towards the loop until all of the clamps have been torqued.
- Re-check torque on nuts frequently after rope has been in service.

RIGGING AND SLINGING

From SWP 030 (Rev 3)

- • CSA approved boots, CSA/ANSI safety glasses, CSA approved hard hat, and reflective vests must be worn.
- • WHMIS, positional training, hand signal training, rigging inspection training, Hazard Assessment, Safe work Practices/Procedures. (All Rigging personnel must sign off on the training package) are all of the types of training required.
- • Rigging must be inspected daily.
- • Always know the weight of the lift, the center of gravity, and ensure rigging is proper.
- • Riggers must be competent in hand signals.
- • Tag lines must be used when practical and riggers must be competent to control the tag line.
- • Never walk or reach under a load, watch out for pinch points, never get between the load and buildings, vehicles, stored material, etc.
- • Never ride loads.
- • Name one member of the crew to act as a signalman and instruct the equipment operator to recognize signals from that person only. The signalman must be careful not to order a move until he has received the "all ready" signal from each member of the crew.
- • Always start and stop any crane movements slowly, do not jerk the load off the floor at full speed as this will shock load the crane and rigging.
- • When lifting heavy loads, raise the load a few inches and stop. If the load starts to go back down, put it back on the floor and tag the crane out until the brakes have been fixed. Do not attempt to perform a lift if the brakes are not working properly.
- • Always use softeners to protect the rigging from sharp edges, at least 3 links of chain need to be in contact with the softeners.
- • Each rigger must be sure he/she is in the clear before he gives an "all ready" to the signalman. When you have positioned the sling or choker you're using, release it, if possible, before you give the "all ready" signal.
- • If you must hold the sling or choker in position, be sure your hand is clear of pinch points.
- • When turning a load do not allow the load to slip around on the rigging in a basket hitch, as this causes the rigging and crane to be shock loaded, and causes wear to the chains. Always use a turning hitch with the chain hooks pointed away from the direction of the turn. If the load is being turned completely over you will need to reposition the hitch after 90 deg in the turn.
- • Never place yourself between material, equipment, or any stationary object and the load swing. Also, stay away from stacked material that may be knocked over by a swinging load.
- • Watch out for the roll or swing of the load. Since it is almost impossible to position the hook exactly over the load center, there will almost always be a swing or roll. Anticipate the direction of the swing or roll and work away from it.
- • Never stand under to load and keep from under the boom as much as possible. Chances are that nothing will break, but something might.
- • Look over the place where the load is to be set. Remove unnecessary blocks or other objects that might fly up if struck by the load.

HORIZONTAL PLATE CLAMPS

From SWP 107 (Rev 02)

- Always read the owner's manual and the SWP before using the Horizontal Plate Clamp. The owner's manual is located in the tool crib.
- Always perform a pre-use inspection of the Horizontal Plate Clamps before using it, do not use a defective Horizontal Plate Clamp. Tag it out and notify your supervisor and write a Hazard ID.
- Never exceed the capacity of the Horizontal Plate Clamps, The capacity rating marked on the clamps is for **a pair not each clamp**. That's because Horizontal Plate Clamps must be used in pairs, **directly opposite each other**.
- Always keep the load level and maintain an angle of 60 deg's with the rigging material, do not side load Horizontal plate clamps. If you need to use more than two pairs of clamps you must use two cranes or a spreader bar to prevent side loading of the clamps.
- Always maintain a safe distance, never stand near a suspended load.
- Horizontal plate clamps are for lifting flat plate only, do not attempt to lift Tapered or conical materials.
- Lift the load slowly, do not lift the load off the floor at full speed, shock loading of the crane and rigging will occur.
- Do not modify the lifting clamp in any way, avoid exposing the clamps to excessive heat and do not grind on the clamps.
- Always use a shackle to attach the crane rigging to the clamps. Ensure that the shackle is large enough to allow the hook to move freely.
- Always place the load on top of suitable blocking or racks so the clamps can be removed easily. Never place the load on top of the plate clamps and use a hammer to knock the clamps from under the load.
- Ensure that the clamps are maintained as per the manufactures instructions.
- Any improper use of the clamps and/ failure to observe the instructions and warnings in this SWP and the owner's manual may endanger the health and safety of the user and/ or bystanders.

UNIVERSAL JOINT PLATE CLAMPS

From SWP 34 (Rev 02)

- Always read the owner's manual and the SWP before using the universal joint plate clamp. The owner's manual is located in the tool crib.
- Always perform a pre-use inspection of the plate clamp before using it, do not use a defective plate clamp. Tag it out and notify your supervisor and write a Hazard ID.
- When using a pair of universal joint plate clamps in a bridal hitch, do not go below an angle of 60 deg's
- .When placing a load down, put it on top of suitable blocks. Do not place the plate on top of the clamp and hammer on the clamp to get it off the plate.
- Universal joint plate clamps have a maximum and a minimum capacity, the minimum capacity is 10% of the maximum. Less than that and the plate clamp may not generate enough gripping force to hold the plate securely.
- The plate to be lifted must be free of Rust, Paint, Mill scale and any other contamination that could cause the clamp to lose its grip.
- Always maintain a safe distance from the load, use a tag line if necessary to control the load. Vice grips can be used to provide a tie off point on the plate for the tag line.
- Always warn others in the area before starting to lift the plate, do not carry a load near other workers.
- Inspect the plate clamp after every use, tag out any clamp that fails inspection and return it to the tool crib for repair or replacement. Notify your supervisor by writing a hazard ID.
- Any improper use of the plate clamp or failure to observe instructions in the owner's manual and this SWP may result in property damage, personal injuries or death.

SCREW CLAMP TSCC

From SWP 103 (Rev 2)

- The Terrier safety TSCC Lifting clamp is named after the safety mechanism which is made up of a spindle pivot and a cam. On tightening the spindle, there will be constant pressure on the pivot and cam. The clamp therefore cannot slip upon taking up the load. When lifting the load, the clamping strength of the clamp is increased by the weight of the load and the angle of the cam. Also when depositing a load, the clamp cannot spontaneously let go.
- Always read the owner's manual and the SWP before using the TSCC Screw clamp. The owner's manual is located in the tool crib.
- Do not exceed the capacity marked on the screw clamp.
- Keep a safe distance during lifting work and never walk or stand under the load. Never lift more than one piece at a time.
- Clean the area where the clamp is to be attached, removing any grease, oil, dirt corrosion and mill scale.
- Make sure that the clamp (or clamps) are attached in a way that the load is balanced during the lift.
- The surface of the material being lifted must not be harder than 37HRC (345HB, 1166 N/MM²).
- Do not make any modifications to the clamp (welding, grinding, etc.), as such modifications may negatively affect its operation and safety. Also any such modifications will void the warranty.
- Ensure that the rigging has adequate capacity for the weight of the load.
- Secure the clamp by completely tightening the spindle, use at least 40Nm.
- Hoist steadily to allow effective gripping on taking up the load.
- Ensure the load is in a stable position before removing the clamp.
- Position the clamp so as to avoid exposing it to extreme heat and arc strikes.
- Refer to section 6 of the owner's manual for maintenance instructions, only qualified persons are to perform any maintenance and use only manufacturers approved parts and procedures.
- Return the clamp to the tool crib in a clean undamaged condition. Tag out any clamp that has been damaged.

VERTICAL PLATE CLAMPS

From SWP 077 (Rev 02)

- Always read the owner's manual and the SWP before using the Vertical plate clamps. The owner's manual is located in the tool crib.
- Always perform a pre-use inspection of the plate clamp before using it, do not use a defective plate clamp. Tag it out and notify your supervisor and write a Hazard ID.
- Vertical plate clamps are for vertical lifting only, do not use this type of plate clamp in a bridal hitch.
- Refer to the thickness capacity of the clamp and stay within the manufactures recommended specifications.
- Plate clamps have a minimum and a maximum capacity, the Minimum capacity is 10% of the maximum capacity.
- Before every lift inspect the plate clamp for damage, do not use a defective clamp. Also inspect the material to be lifted for excessive rust, mill scale and paint and any other material that could affect the clamps ability to grip the surface.
- Do not pass a load over other workers, always warn others in the area before you start a lift.
- Do not place the load down on top of the plate clamp, use suitable blocking material to facilitate the removal of the clamp. Never hammer on a plate clamp to get it from under a load.
- Never use a vertical plate clamp to lift cylinder shaped loads.
- Handel plate clamps with care, never throw a plate clamp off the top of structures onto the floor.
- Do not hold onto the plate to control the load, always use a tag line. Tag line can be attached to a plate using a pair of vice grips. Keep a safe distance from the load at all times.
- When not in use store the plate clamp in the designated storage area, always inspect the plate clamp for damage before storing it away.
- Any plate clamp that fails inspection must be tagged out and returned to the tool crib for repair or replacement. Notify your supervisor by writing a hazard ID.

BREAKING STRENGTH OF WIRE ROPE

(6 X 19 CLASSIFICATION)

Rope diameter (in.)	Weight (lb. per ft.)	Breaking strength in tons of 2,000 lb.		Rope diameter (in.)	Weight (lb. per ft.)	Breaking strength in tons of 2,000 lb.	
		Plow steel	Improved plow steel			Plow steel	Improved plow steel
3/16	0.06	1.3	1.5	3/16	0.07	1.4	1.6
¼	0.10	2.4	2.7	¼	0.11	2.6	2.9
5/16	0.16	3.8	4.1	5/16	0.18	4.1	4.4
3/8	0.23	5.4	6.0	3/8	0.25	5.8	6.5
7/16	0.31	7.0	8.0	7/16	0.34	7.5	8.6
½	0.40	10.0	11.0	½	0.44	10.8	11.8
9/16	0.51	11.7	13.3	9/16	0.56	12.6	14.3
5/8	0.63	15.0	16.5	5/8	0.69	16.1	17.7
¾	0.90	21.5	23.8	¾	0.99	23.1	25.6
7/8	1.23	28.3	32.0	7/8	1.35	30.4	34.4
1	1.60	38.0	41.7	1	1.76	40.8	44.8
1 1/8	2.03	48.5	53.0	1 1/8	2.23	52.1	57.0
1 ¼	2.50	60.0	65.0	1 ¼	2.75	64.5	70.4
1 3/8	3.03	73.5	81.0	1 3/8	3.33	79.0	87.1
1 ½	3.60	88.5	96.0	1 ½	3.96	95.1	103.0
1 5/8	4.23	103.0	113.0	1 5/8	4.65	111.0	122.0
1 ¾	4.90	119.0	130.0	1 ¾	5.39	128.0	140.0
1 7/8	5.63	138.0	152.0	1 7/8	6.19	148.0	163.0
2	6.40	154.0	169.0	2	7.04	166.0	182.0
2 ¼	8.10	193.0	210.0	2 ¼	8.91	208.0	226.0
2 ½	10.00	235.0	260.0	2 ½	11.00	253.0	280.0
2 ¾	12.10	280.0	305.0	2 ¾	13.30	301.0	328.0

(6 X 37 CLASSIFICATION)

Rope diameter (in.)	Weight (lb. per ft.)	Breaking strength in tons of 2,000 lb.		Rope diameter (in.)	Weight (lb. per ft.)	Breaking strength in tons of 2,000 lb.	
		Plow steel	Improved plow steel			Plow steel	Improved plow steel
¼	0.10	2.2	2.5	¼	0.11	2.4	2.7
5/16	0.16	3.8	4.0	5/16	0.18	4.1	4.3
3/8	0.22	5.0	5.5	3/8	0.24	5.4	5.9
7/16	0.30	6.9	7.5	7/16	0.33	7.4	8.1
½	0.39	9.2	10.0	½	0.43	9.9	10.8
9/16	0.49	11.4	12.5	9/16	0.54	12.3	13.4
5/8	0.61	14.5	16.0	5/8	0.67	15.6	17.2
¾	0.87	20.2	22.2	¾	0.96	21.7	23.9
7/8	1.19	27.5	30.2	7/8	1.30	29.6	32.5
1	1.55	36.0	39.5	1	1.1	38.7	42.5
1 1/8	1.96	44.0	49.0	1 1/8	2.16	47.3	52.7
1 ¼	2.42	55.0	61.0	1 ¼	2.66	59.1	65.6
1 3/8	2.93	68.5	74.5	1 3/8	3.22	73.6	80.1
1 ½	3.49	82.0	90.0	1 ½	3.84	88.1	96.7
1 5/8	4.09	96.5	105.5	1 5/8	4.50	104.0	113.0
1 ¾	4.75	110.0	121.0	1 ¾	5.23	118.0	130.0
1 7/8	5.45	129.0	142.0	1 7/8	6.00	139.0	153.0
2	6.20	142.0	155.0	2	6.82	153.0	167.0
2 ¼	7.85	182.0	201.0	2 ¼	8.64	196.0	216.0
2 ½	9.69	225.0	245.0	2 ½	10.66	242.0	263.0
2 ¾	11.72	269.0	293.0	2 ¾	12.89	289.0	315.0
3	13.95	323.0	353.0	3	15.35	347.0	379.0