



ARTICULATED BOOM TRUCK OPERATOR SAFETY TRAINING



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

SAMPLE

TYPES OF MOBILE CRANE



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SAMPLE

BOOM TRUCK INSPECTION CHECKLIST

INSPECTION AREA	INSPECTION RESULTS			Comments
	Sat.	Unsat.	N/A	
Carrier				
Engine Oil				
Radiator				
Suspension				
Tires				
Wheels				
Rotation System				
Outriggers				
Mounting Bolts & Welds				
Hydraulic Fluid Levels				
Carrier Structure				
Oper. Station & Turret				
Gauges				
Controls & Labels				
Hydraulic Cylinders				
Hydraulic Hoses				
Warning Alarms				
Service Brakes				
Swing Brakes				
Electrical System				
Safety Equipment				
Boom				
Sheaves				
Wire Rope				
Hook & Swivel				
Boom Angle Indicator				
Load Indicators				
Anti-Two-Block System				
Winch				
Slide Pads				
Deformations, Cracks				
Boom Extension				
Load Block				



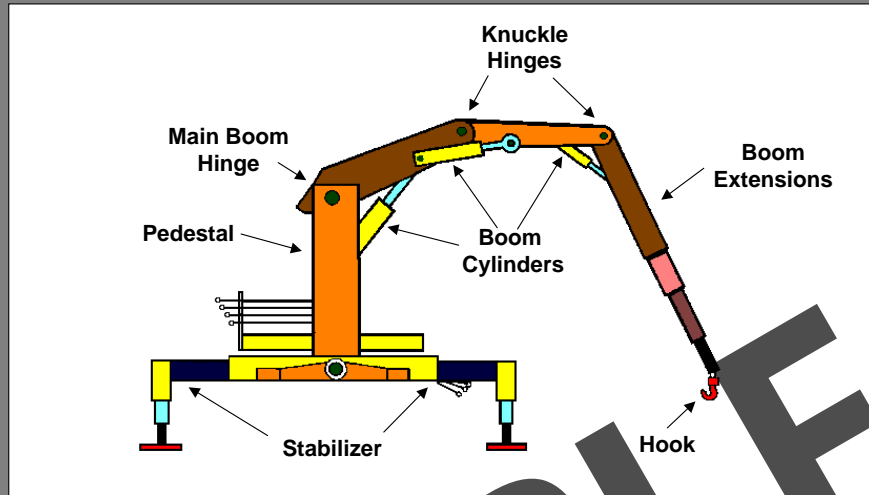
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OBJECTIVE: To present the inspection checklist to the students.

1. The inspection checklist is introduced now so that the students can refer to it during the discussions regarding the mechanical structure of the crane.
2. Review briefly the items on the checklist but do not go into any detail at this time.

CRANE COMPONENTS



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STABILIZER SECTION

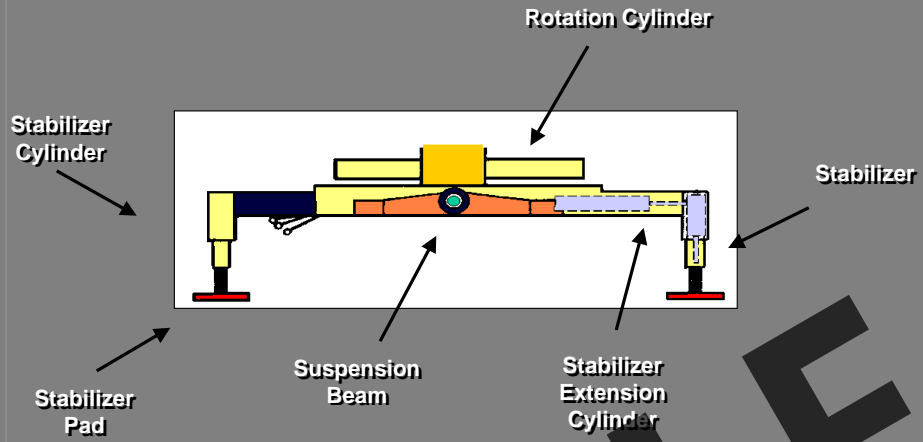


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STABILIZER SECTION

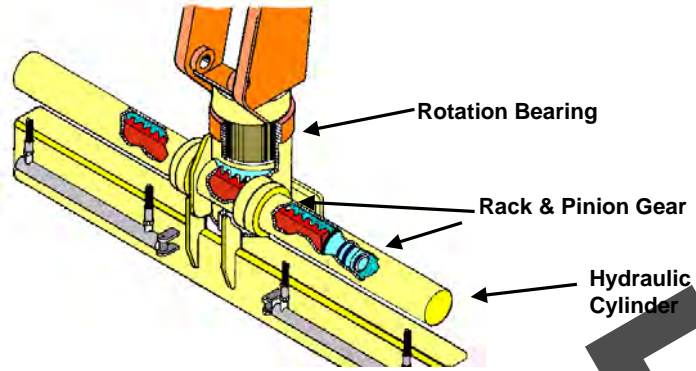


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TURRET SECTION



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BOOM & TURRET INSPECTION

Damaged Hydraulic Hoses

Worn pins



Cracked Welds

Damaged cylinder rods

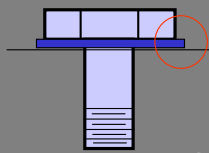


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CHECKING FOR TIGHTNESS



Note The Accumulation
Of Dirt And/or Paint

Cracks In Paint Or Dirt Build-up
Often Is Caused By Loose Bolts.

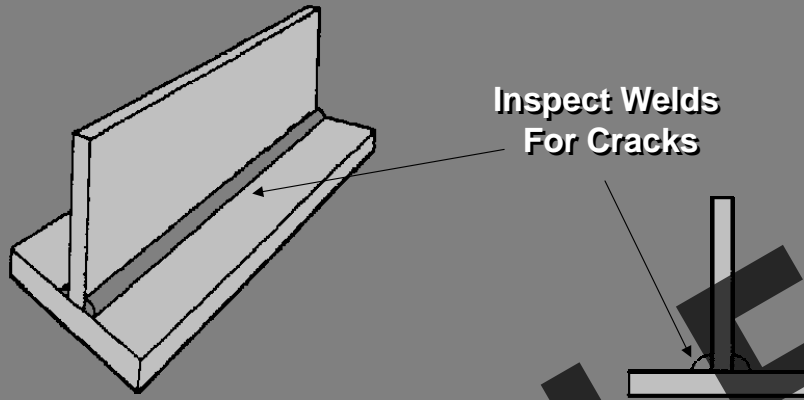


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CRACKED WELDS



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BOOM & TURRET INSPECTION



Damaged or bent extension cylinders

Damaged or bent boom sections



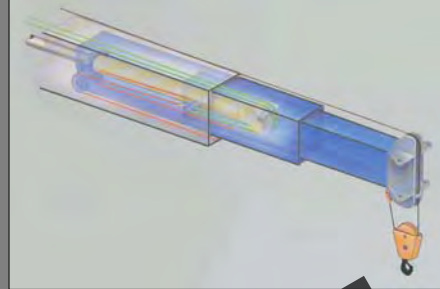
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OBJECTIVE: To do an overview of the whole crane components.

1. Use this slide to discuss the parts of the crane that have not been covered yet.
2. All welds need to be checked for cracks.
3. The boom needs to be extended and check for smoothness of operation. Any binding or difficulty in extending could be the result of damaged boom sections.
4. Any hydraulic leaks need to be investigated and repaired. Check the hoses for chaffing and damage.
5. The slide pads can be checked for proper alignment by extending the boom completely and lowering the tip toward the ground. Move the boom tip back and forth by pushing on it and observing how much the boom sections move inside each other. Excessive movement will require the slide pads to be adjusted or replaced.
6. The boom tip needs to be checked to deformation and twisting.
7. The next few slides provide more details.

BOOM & TURRET INSPECTION

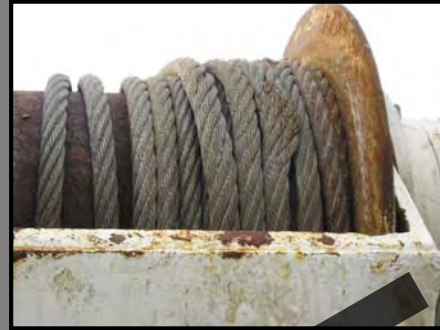


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SAMPLE

WINCH



CAREFULLY
MONITOR
REEVING



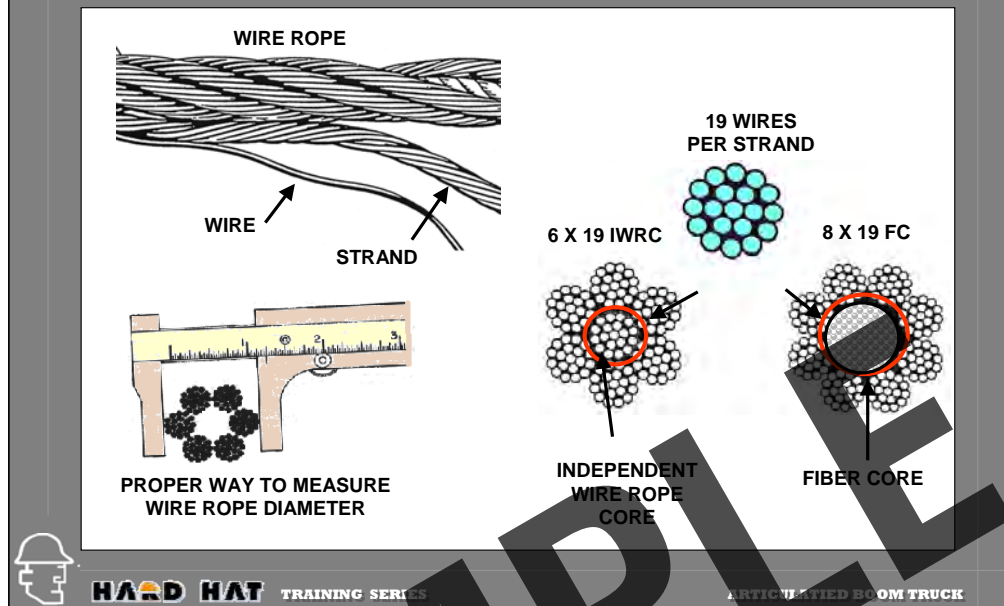
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OBJECTIVE: The spooling of the wire rope on the winch needs to be monitored regularly to prevent damage.

1. One of the most common causes of damaged wire rope on boom trucks is from crushing due to spooling problems.
2. The operator needs to monitor the winch to prevent the wraps from loosening and allowing the wire rope to cross over itself.
3. Loosely wrapped wire rope needs to be un-spooled and then re-spooled on the winch properly to prevent damage.

WIRE ROPE CONSTRUCTION



OBJECTIVE: To discuss the construction of wire rope.

1. Wire rope comes in various sizes and construction. The most common is the right regular lay wire rope of the 6X19 class.
2. The strands of a wire rope are made up of several wires twisted together.
3. Several strands are twisted together to form the wire rope.
4. Common wire rope will have either a fiber core or an independent wire rope core or IWRC. For lifting purposes, IWRC is recommended because it resists crushing.
5. The designation, 6X19, refers to the basic construction. The '6' stands for the number of strands, not counting the core, that are used in the rope. The '19' refers to the number of wires in each strand.
6. When measuring the diameter of wire rope, make sure to measure across the strands and not the flat area between the strands.

ROTATION RESISTANT WIRE ROPE



The non-rotating characteristic is secured by building into the rope two layers of strands, one having Right Lay and the other Left Lay.

The tendency of one layer of strands to rotate in one direction is counteracted by the tendency of the other layer of strands to rotate in the opposite direction.



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OBJECTIVE: To discuss rotation resistant rope and how it is constructed differently than other types of wire rope.

1. Point out how non-rotating rope is constructed. It has two layers of strands, one Right Lay and the other Left Lay.
2. These two layers rotate against one another, counteracting to keep the rope from rotating.

ROTATION RESISTANT WIRE ROPE

Rotation Resistant wire rope require very careful handling prior to, during and after installation. When a non-rotating rope is cut, bent around a thimble or wedge socket, or is attached to any fitting, care must be taken to prevent **core slippage**.

Core slippage can happen quite easily. When the rope is twisted in one direction, one layer of strands will tighten up and shorten, while the other layer of strands loosens, or becomes longer. As a result the shorter layers of strands carry the majority of the load.

To ensure that core slippage does not take place, always apply **wire seizings** to bind the inner and outer cores together before the rope is cut or attached to any fitting.

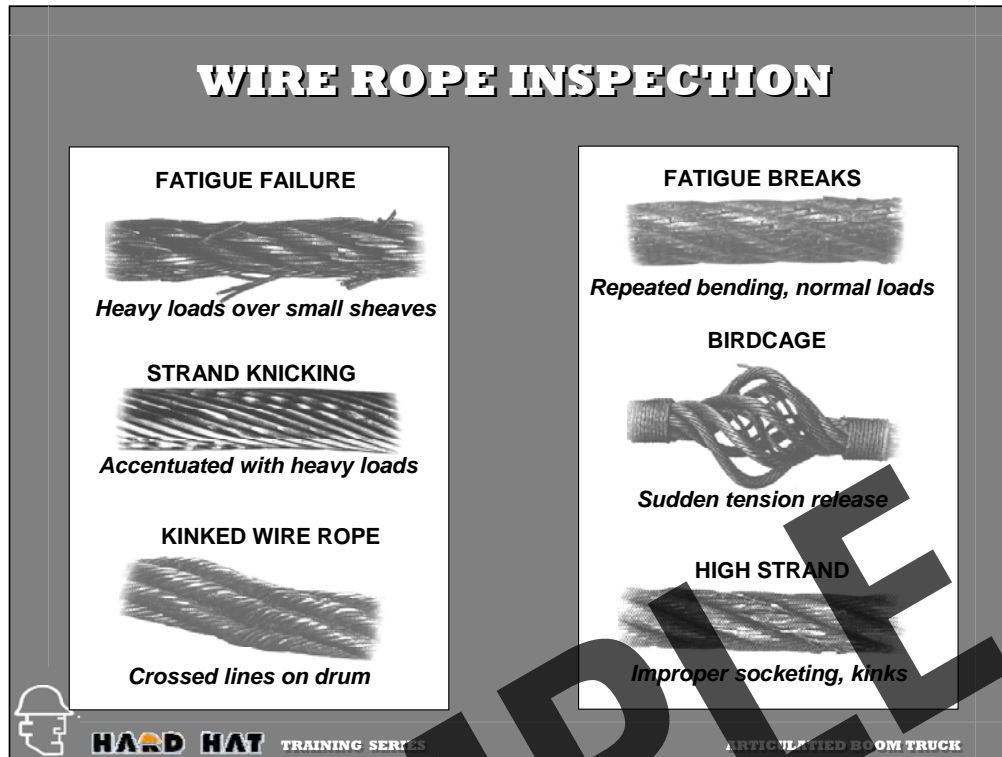


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OBJECTIVE: To emphasize why Rotation Resistant wire rope must be handled differently than other types of wire rope.

1. Since Rotation Resistant rope is so different from other types of wire rope, the industry lists separate standards for its use.
2. Most Rotation Resistant rope's safety factor is at least 5:1. It is 10:1 when hoisting personnel.
3. ANSI has very strict procedures that must be followed when operating wire rope under a 5:1 safety factor
4. Rotation Resistant rope does not react well to bending around sheaves, thimbles or wedge sockets. Many manufacturers discourage the use of wedge sockets with non-rotating rope.
5. Great care must be taken when cutting non-rotating rope or attaching it to any fitting. To ensure that core slippage does not take place, the ends must have wire seizings applied prior to cutting or attaching it to any fitting.
6. Rotation Resistant wire rope should be inspected often.

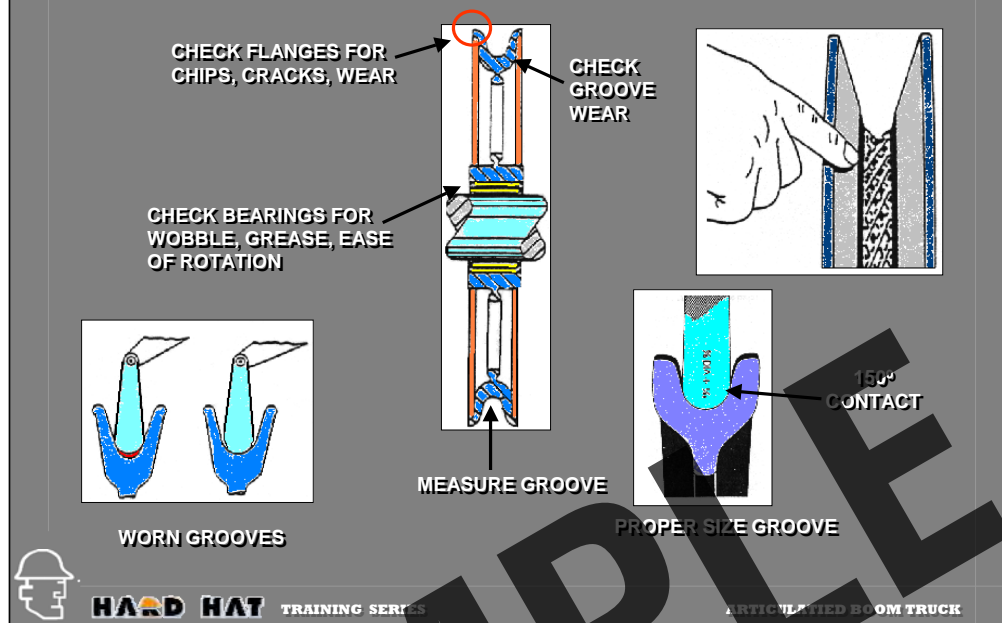


OBJECTIVES: How to identify different types of wire rope problems.

1. Note the different types of damage and their causes.
2. Kinked rope is common on small cranes because of over running the wire rope when winching down.

AFTER THIS DISCUSSION HOLD A BRIEF REVIEW OF THE CRANE INSPECTION AND THEN ADJOURN TO THE CRANE FOR HANDS A HANDS ON EXERCISE. HAVE EACH PARTICIPANT CONDUCT AN INSPECTION.

INSPECTING SHEAVES



OBJECTIVE: Review the inspection of the sheaves.

1. Check for bearing wear and lubrication.
2. Check the flanges and treads.
3. Show how to use a sheave gauge.
4. Sheaves can only be repaired per manufacture's procedures.

CRANE CONTROLS



Controls need to be properly labeled and function smoothly



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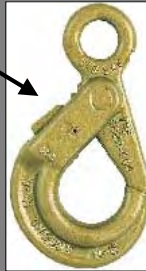
SAMPLE

HOOK INSPECTION

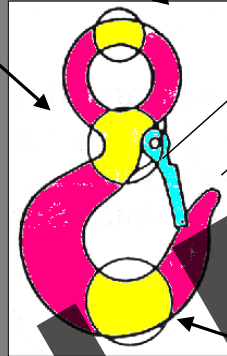
CHECK FOR:

- ✓ Wear
- ✓ Deformation
- ✓ Cracks & Sharp Nicks
- ✓ Modifications
- ✓ Safety Latches
- ✓ Swivel Wear & Lubrication
- ✓ Hook Shackle Housing

Check Safety
Latch & Spring



Cracks &
Twisting



Wear &
Deformation

"Opening
Up"

Wear &
Cracks

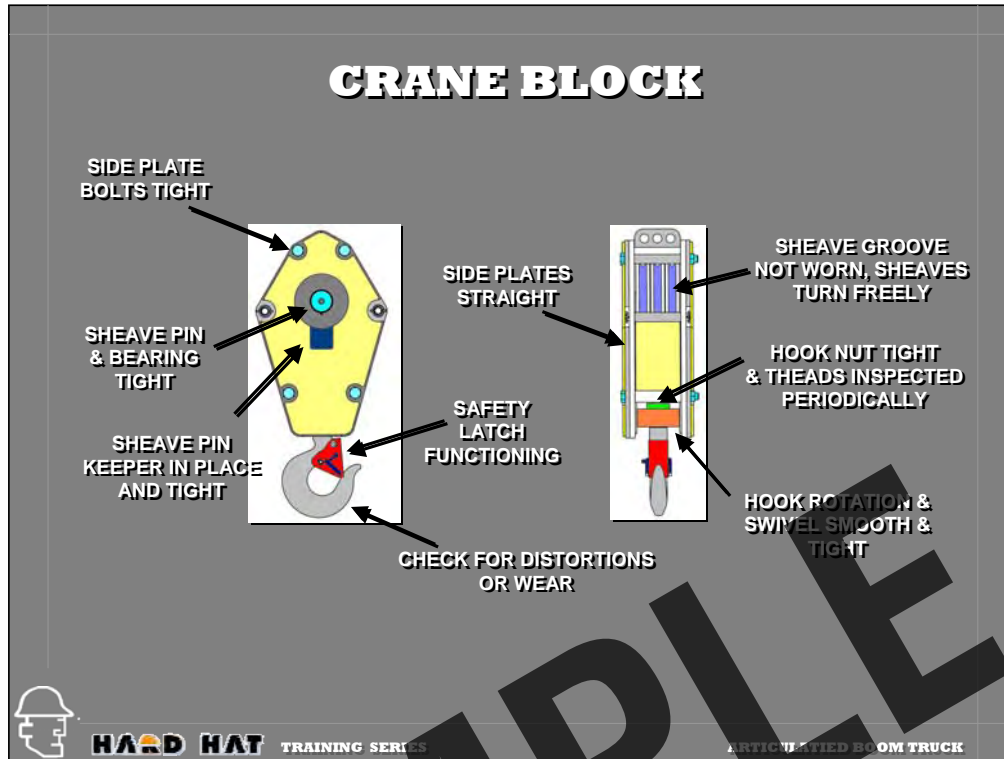


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OBJECTIVE: Point out inspection areas for different types of hooks and blocks.

1. Hooks with threads and nuts need to have threads inspected periodically.
2. Hooks can only be repaired per manufacturer's procedures.
3. Wear in excess of 5% in the neck of the hook and 10% in other areas including the bow of the hook is cause for removal.
4. An increase in the hook throat opening of more than 15% is cause for removal.
5. Any twist in the hook of more than 10% is cause for removal.
6. The hook safety latch should be present and function properly.



OBJECTIVE: To review the inspection criteria for hook blocks.

1. The sheaves and bearings need to be inspected as discussed earlier.
2. The side plates and any additional weights attached to their sides need to be inspected for loose or missing bolts or other fasteners.
3. The hook should rotate freely on the swivel bearing. Check for excessive movement.
4. The hook shank and nut should be separated periodically and the threads inspected for corrosion and other damage. The loss of more than 20% of the treaded area due to corrosion is cause for removal.
5. The safety latch must be in place and functioning properly.



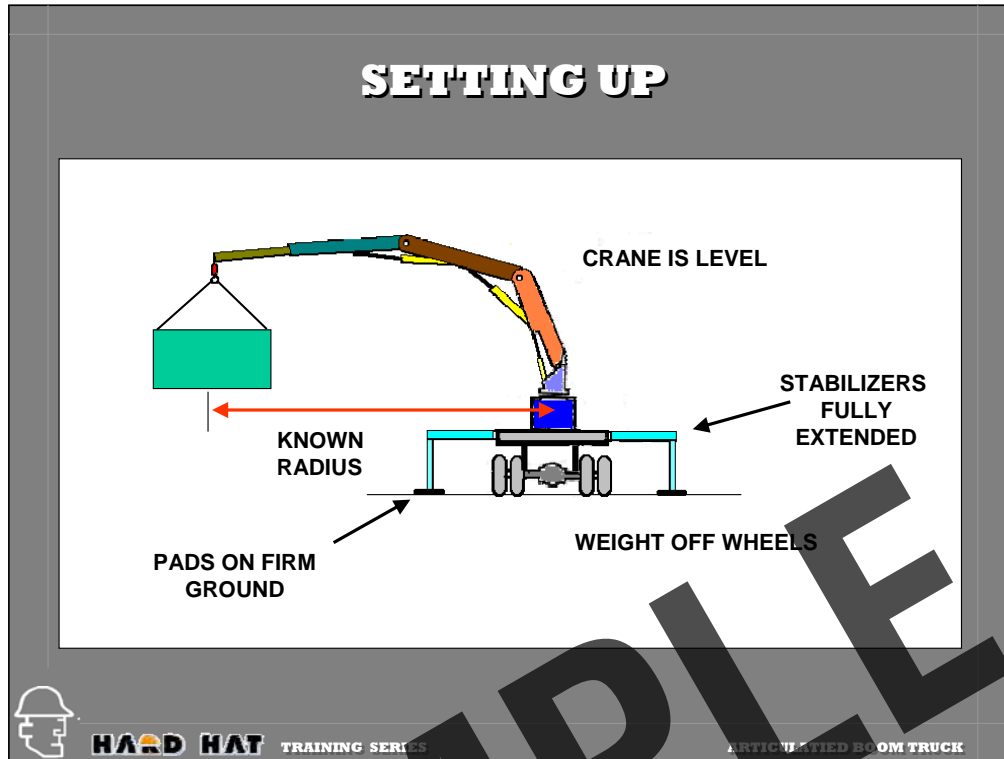
BOOM TRUCK SETUP



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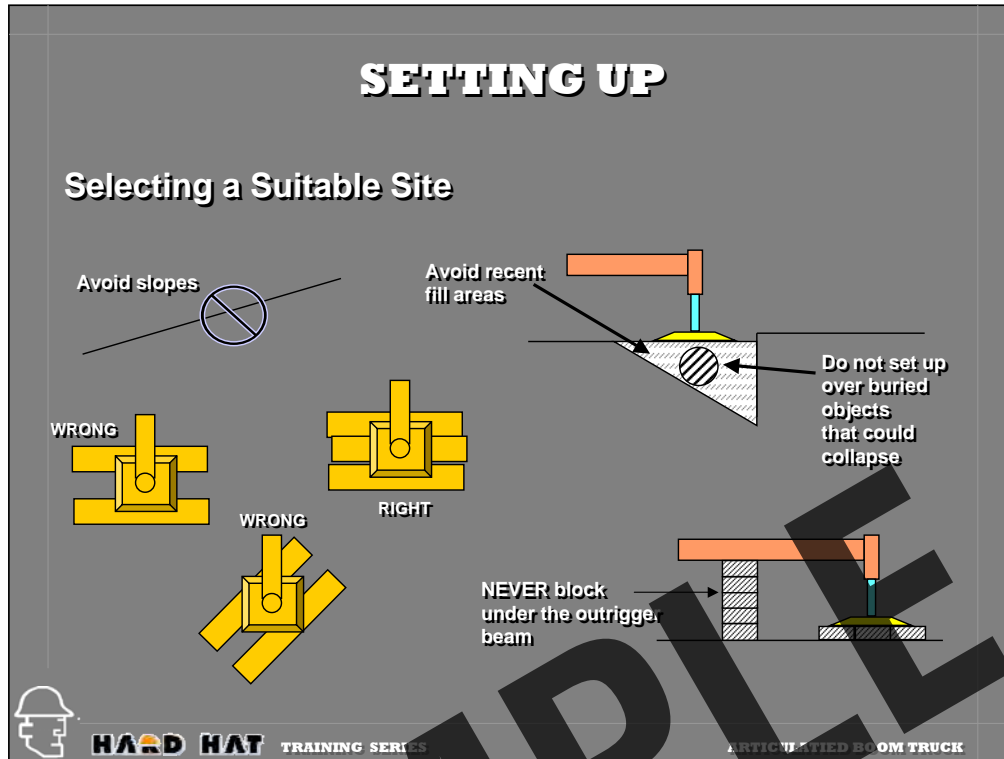
ARTICULATED BOOM TRUCK

SAMPLE



OBJECTIVE: This slide introduces the topic of boom truck set up.

1. Point out each of the areas that need to be taken into consideration when setting up the boom truck.
2. When the stabilizers are fully extended the tires may not be off the ground but the weight of the truck will primarily be on the stabilizers.

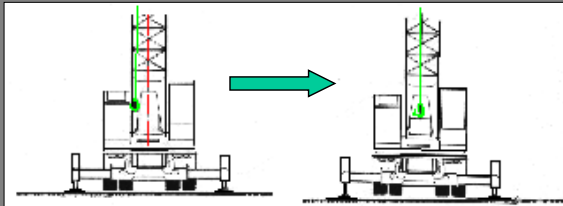


OBJECTIVE: To discuss the consideration that need to be understood to safely set the boom truck up.

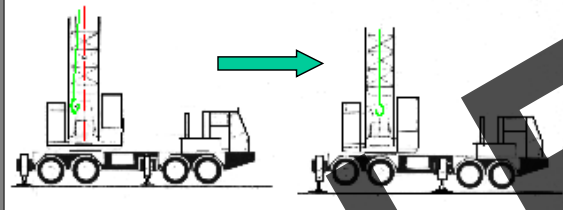
1. The first consideration is the quality of the surface the boom truck will be set up on.
2. Soils along the foundation of buildings are often poorly compacted and may contain drain pipe and other voids. Setting up in these areas should be avoid when possible and additional floats used when not.
3. Floats of at least 24" X 24" should be used under each stabilizer pad regardless of the type of surface being set up on. The use of these floats will reduce the pounds per square inch loading on the surface which will help prevent the stabilizer from sinking.
4. Blocking under the A-frame type of stabilizer which prevents the stabilizer from fully deploying should be avoid. Doing so will shorten the distance from the stabilizer pad to the center of rotation which results in a lose of leverage for the boom truck and makes it more likely to tipping over.
5. Always extend both outriggers. Not doing so can result in the boom truck tipping over.

LEVELING THE CRANE

SWING BOOM OVER
REAR & LEVEL
CRANE UNTIL HOIST
WIRE IS PLUMB WITH
BOOM



SWING BOOM OVER
SIDE & LEVEL CRANE
UNTIL HOIST WIRE IS
PLUMB WITH BOOM



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ARTICULATED BOOM TRUCK

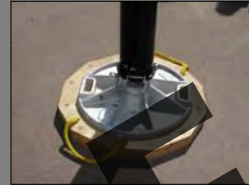
OBJECTIVE: To show how a crane can be leveled using the hoist line and the boom.

1. Leveling may take a few minutes but it is very important.
2. Boom trucks typically have a bubble level mounted at the control station which is used for leveling the crane.
3. In the absence of a bubble level, a carpenter's level can be placed on the turret for leveling purposes. The level will need to be positioned fore and aft and cross-wise to assure leveling in both directions.
4. A third way to level the boom is by using the hoist line as a plumb-bob. This is a very accurate leveling procedure. The above diagram illustrates the basic procedure.

SETTING UP



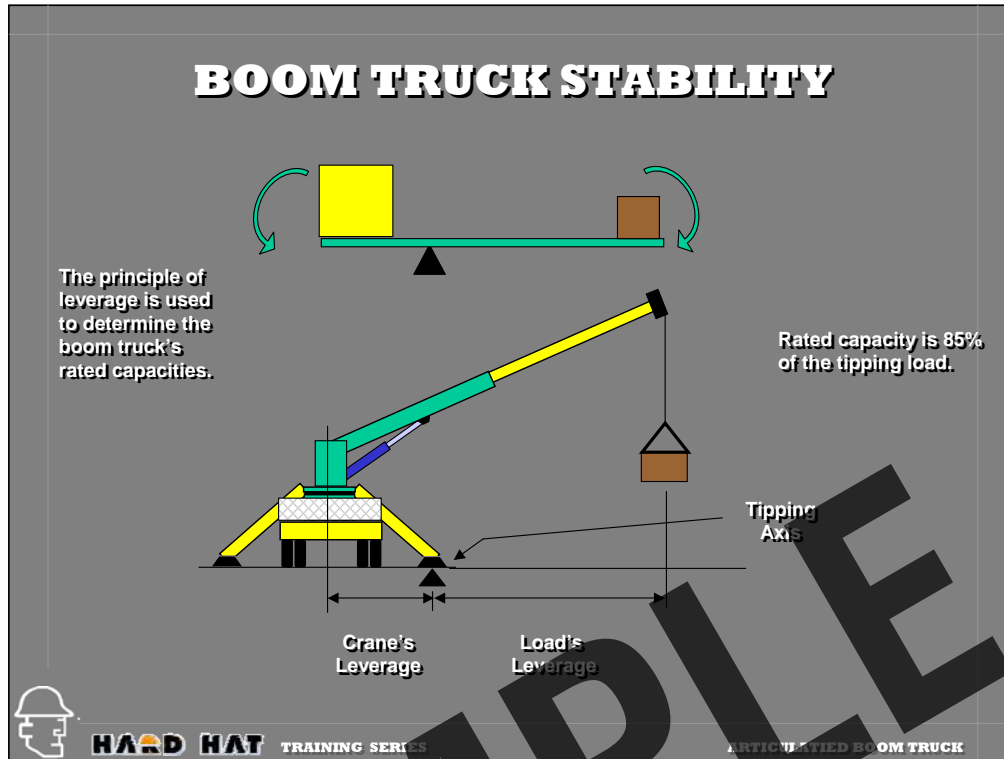
Small stabilizer pad
Should have additional
Floats placed under them



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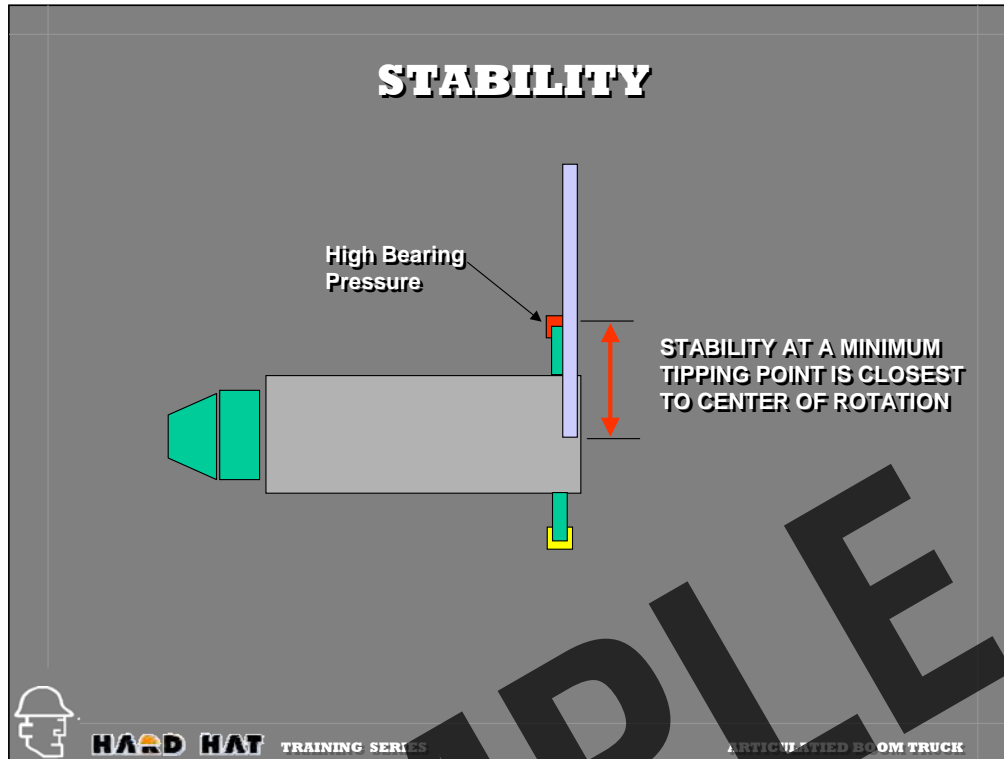
ARTICULATED BOOM TRUCK

SAMPLE



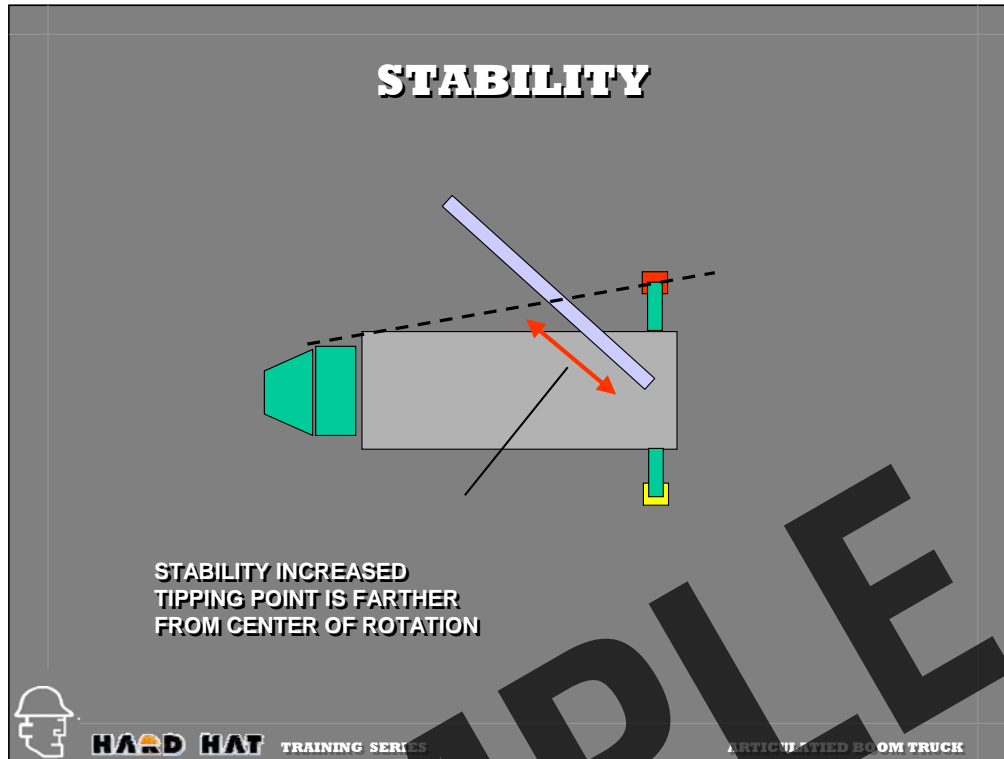
OBJECTIVE: To understand the dynamics of stability.

1. Boom truck stability is based on the concept of balance and leverage.
2. The concept of the teeter-totter is something that most people are familiar with and is a good way to explain stability.
3. When a teeter-totter is in perfect balance, the torque created by the weight times the length of the lever arm on one side of the pivot point must equal the torque created by the weight times the lever arm length on the other side.
4. For all cranes, the torque on the side of the crane always must be greater or otherwise the crane will tip over. The crane's torque or leverage is the effective weight of the crane times the distance from the center to the stabilizer. Leverage for the load is the weight of the load and that portion of the boom that is beyond the stabilizer pad times the distance from the stabilizer pad to the center of the load.
5. Note that the total weight of the load, boom, and a portion of the truck weight is on the stabilizer(s) over which the boom is working.



OBJECTIVE: To understand how the stability of the crane changes as the boom is rotated.

1. When the boom is located directly over the stabilizer, the pressure applied to the ground is the greatest because this one stabilizer is supporting most of the load.
2. Most boom truck pads are 12"X16" which equals 192 sq. in. of surface pressing on the ground. The load placed on this pad can be in the neighborhood of 20,000 lbs. This would result in a ground bearing pressure of 100 lbs per sq. in.
3. For this pressure the ground would need to be hard pan or compacted gravel soils. For many sites the soil conditions are poor and may be only able to support 40 lbs per sq. in.
4. A 24" X 24" float placed under the stabilizer pad will increase the surface area to 576 sq. in. This will yield a ground bearing pressure for the above situation of 34 lbs per sq. in. This is a much improved situation.
5. The students should be highly encouraged to have a set of floats for their boom truck and to use them for every set-up regardless of the soil conditions.



OBJECTIVE: To show how the load on the stabilizers change as the boom is rotated.

1. As the boom moves from over the forward stabilizer toward the back of the truck the pressure on the ground is shared by the two stabilizers.
2. The distance from the crane's center to the tipping moment line has increased so the leverage for the truck has increased making the boom truck more stable.
3. The students need to be cautioned about picking a load over the rear of the truck and swinging over the side. When initially picked, the boom truck may be very stable but as the load is swung over the side the boom trucks leverage decreases and making the truck less stable. Many operators are deceived by this condition and have resulted in a tip over.

STABILITY



REMEMBER

*THE STABILITY OF THE CRANE
IS EXTREMELY COMPROMISED
WHEN THE STABILIZERS ARE
NOT FULLY EXTENDED!*



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SAMPLE

LIFT REQUIREMENTS

- The Big Picture
- Assessing the Load
- Rigging Requirements
- Assessing the Pick Area
- Assessing the Placement Area



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OBJECTIVE: To review the things the operator needs to consider before making a lift.

1. **The Big Picture.** The operator should take a moment to study the area in which he will be working. Look for power lines, obstructions, vehicle and pedestrian traffic, ground conditions and other potential areas to avoid in set-up.
2. When assessing the load the operator must know the weight. Along with this the load's center of gravity must be known in order to rig properly. Also the load's structural strength must be assessed to ensure that it will not be damaged during the lift.
3. What type of rigging will be required needs to be determined. The operator needs to ensure that the rigging is equal to the job.
4. Where the load will be picked from and where it needs to be placed must be determined. This is necessary so the boom truck can be placed so that both picking and placing of the load will remain within the load chart.

DETERMINING LIFTING CAPACITY

- Calculate the gross load
- Determine the maximum radius
- Determine the maximum height
- Refer to load chart to determine if lift will be within the boom truck's capacity.



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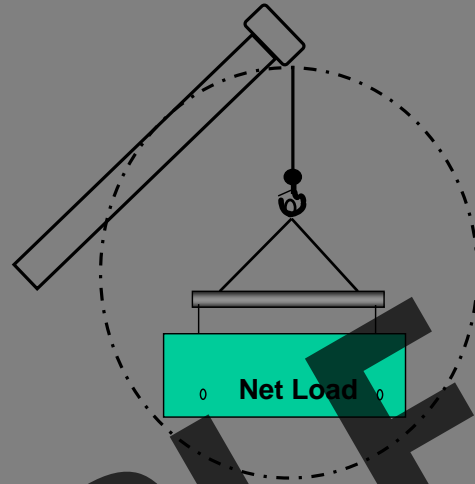
ARTICULATED BOOM TRUCK

OBJECTIVE: To review what things need to be considered for determining if the boom truck is capable of safely making a lift.

1. A discussion of determining what the gross load will be is on the next slide.
2. The operator may need to make a few measurements if the lifting requirements are close to the maximum capacity for a certain configuration. Guessing or even pacing off the radius may result in a tip over if wrong.
3. When placing loads at elevated heights, the operator must know these heights to determine if his boom truck is capable of making the pick.
4. A lengthy discussion on load charts is presented shortly.

GROSS LOAD

Gross Load =
Net Load +
Rigging +
Wire Rope +
Block +
Boom Attachments

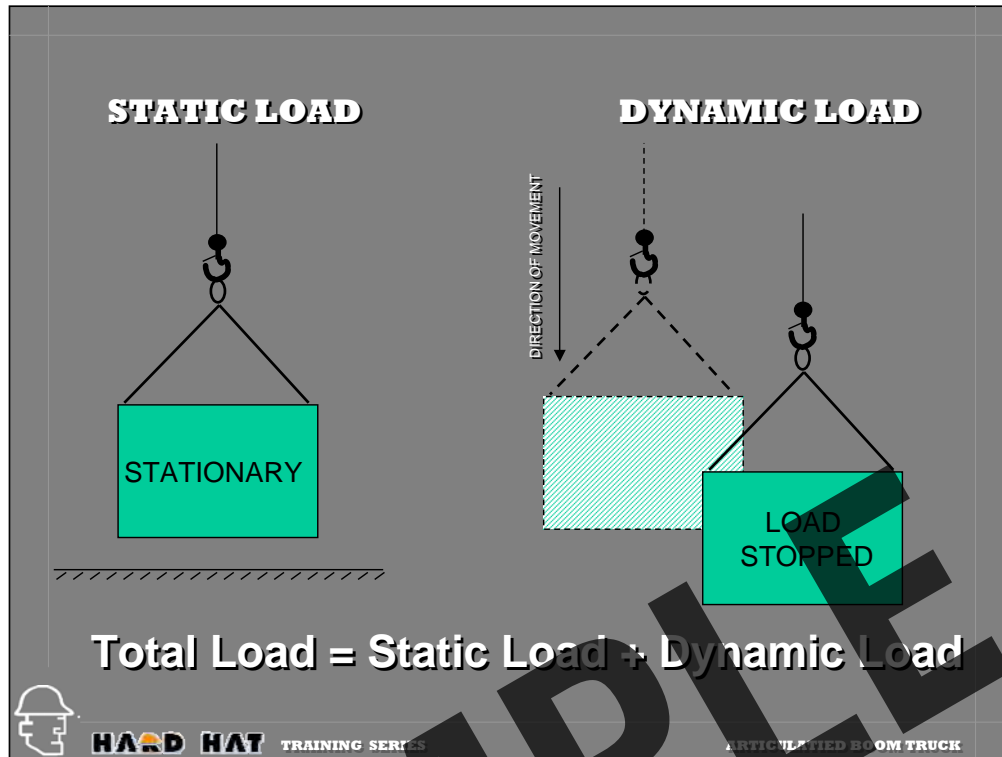


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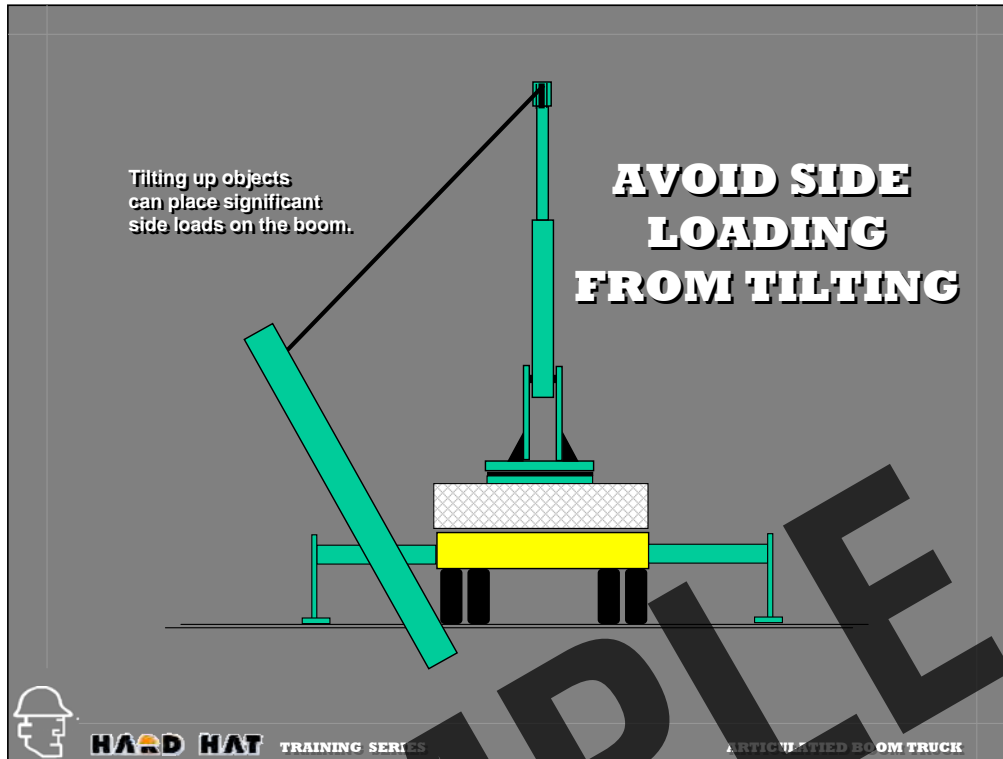
OBJECTIVE: To determine what constitutes the gross load.

1. All crane load charts are based on the load being anything that is hanging below the tip of the boom.
2. All of the above items listed on the slide technically need to be considered but for boom trucks, the weight of the hoist line can be neglected.



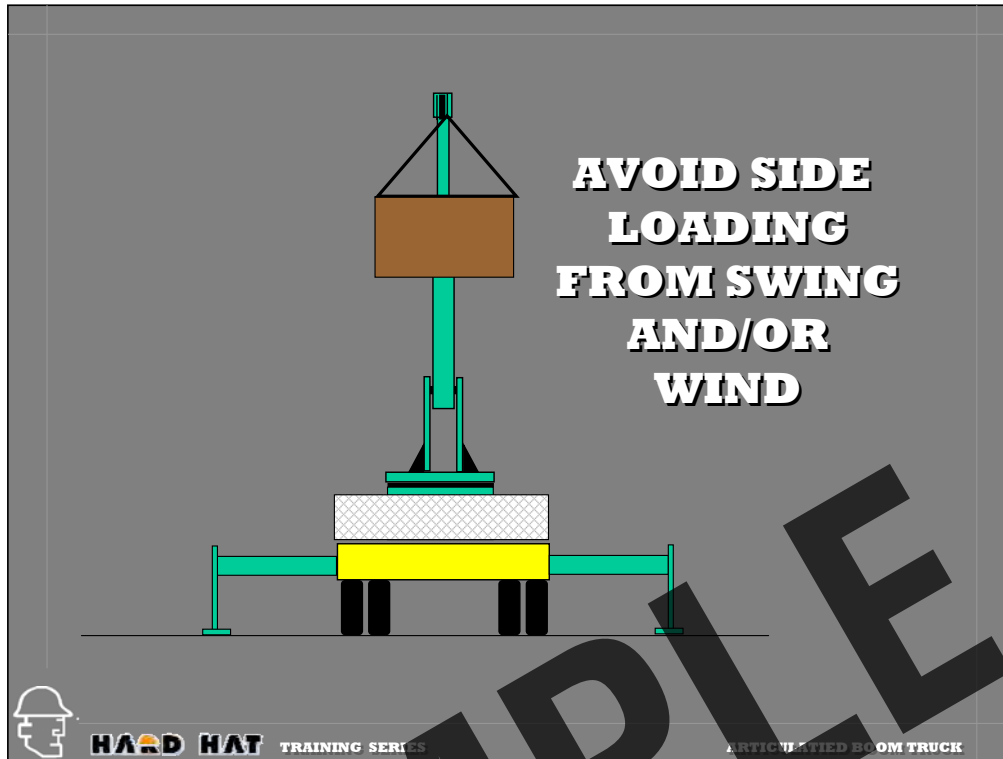
OBJECTIVES: To help the student understand how additional stresses can be imposed on the boom truck when the load is moved.

1. When a load is moved, additional stresses are imposed on the crane's structure.
2. Newton's first and second laws of motion basically state that a body at rest wants to remain at rest and a body in motion wants to remain in motion until acted upon by an outside force.
3. To start a load moving either by hoisting, booming or swinging, the crane will have to exert an additional force. How much additional force imposed is dependent on the weight of the load and how fast a load is started moving. Loads started slowly and stopped slowly will not exert as much stress on the crane as those which are moved rapidly.



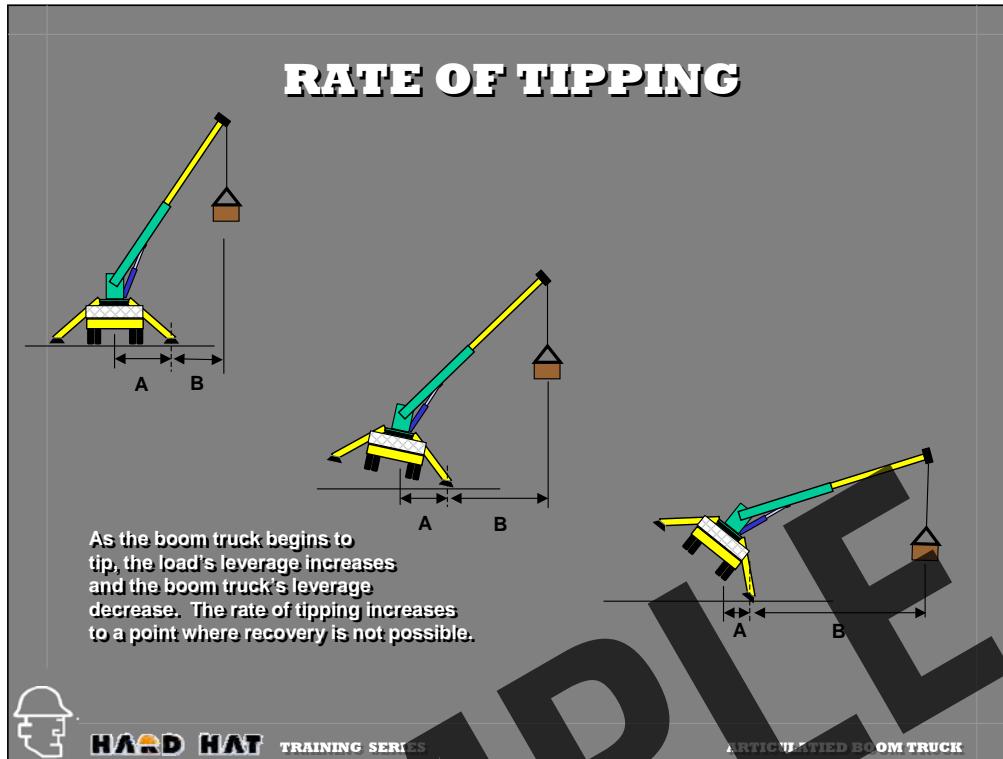
OBJECTIVE: To emphasize the negative impact that side loading can have on the boom.

1. The boom is very susceptible to side loading damage and needs to be above the load at all times.
2. Tilting up panels are a common cause of side loading. When tilting up a panel, the load line must remain vertical at all times.



OBJECTIVE: To show how wind can have a negative affect on the crane.

1. Although it is not very apparent, wind can cause excessive stresses on the crane.
2. Wind on the boom itself, especially when extended fully, can contribute to a tip over. The operator must stop operations when the wind becomes a significant factor. When to stop is left to the judgement of the operator.
3. The wind pressure on the load can also add side loading to the boom as well as loosing control of the load. Tag lines may be necessary to help control the load but should never be used to pull the load around.

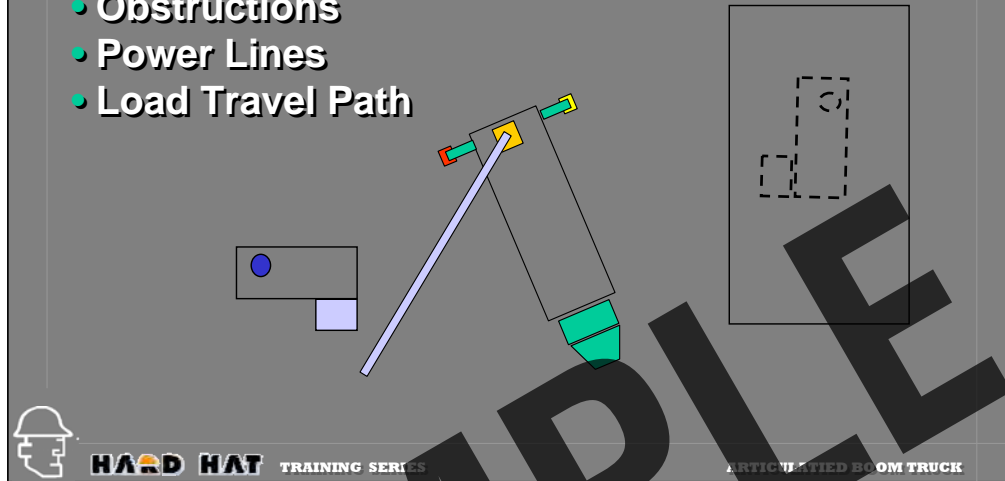


OBJECTIVE: To show how the rate or speed at which a boom truck tips increases the further it tips.

1. When in a stable situation, the boom truck leverage is greater than the load leverage.
2. As the boom truck begins to tip, the distance A becomes shorter and the distance B increases. This results in a decrease in leverage for the truck and an increase in leverage for the load.
3. As the boom truck continues to tip, distance A continues to decrease and distance B continues to increase. Tipping continues to increase at a faster rate.
4. Unless the operator is able to land the load immediately when the rate of tipping is slow, in a matter of seconds, it may be impossible to stop the tipping.

LOCATING THE CRANE

- Ground Stability
- Obstructions
- Power Lines
- Load Travel Path



OBJECTIVE: This slide is to review the requirements for safely placing the boom truck.

1. Note all of the items listed above in determining the exact placement.
2. When the load exceeds 75% of the rated load capacity, the lift is considered a critical lift. Before the lift is attempted, a dry run should be performed to verify the boom truck is adequately located and the lift will remain within the parameters of the load chart.

CRANE SAFETY

Avoid two-blocking the crane, use an anti-two blocking device

Do not leave the crane with a suspended load

Rig the crane with sufficient parts of line for the load

Always have a minimum of three wraps of cable on the drum

Monitor the winch to make sure that it is spooling correctly

Do not lift loads over personnel

Lift one load at a time

Maintain correct electrical clearance

Never use the hoist line as a sling



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OBJECTIVE: To review the points for a safe lift.

SAMPLE

MAKING THE LIFT

Review the lift scenario with the operator, riggers and signal person

Attach taglines when necessary

Position signal person within visibility of the load and operator

Begin by lifting the load slowly

Keep load as low as possible when moving it

Swing slowly to avoid swing out.

Avoid erratic booming

Follow signal and stop operation when uncertain

Lower load slowly



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OBJECTIVE: To review the conditions for making a safe lift.

SAMPLE

HAND SIGNALS



DOG EVERYTHING



EXTEND BOOM



EMERGENCY STOP



**LOWER THE LOAD
RAISE THE BOOM**



RETRACT BOOM



**RAISE THE LOAD
LOWER THE BOOM**



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OBJECTIVE: To review the standard hand signals used in crane operations.

1. Emphasize the importance of using the standard hand signals to avoid misunderstandings which could lead to an accident.
2. When working at night, an orange glove is useful for good visible hand signals.

HAND SIGNALS



RAISE THE LOAD



RAISE THE BOOM



SWING



LOWER THE LOAD



LOWER THE BOOM



STOP



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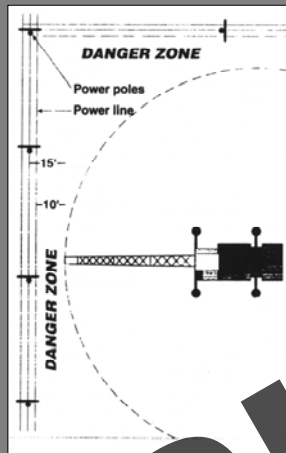
Continuation of previous slide.

SAMPLE

POWERLINE CONTACT

Required Clearances

50kV	10 ft
50 to 200kV	15 ft
200 to 350kV	20 ft

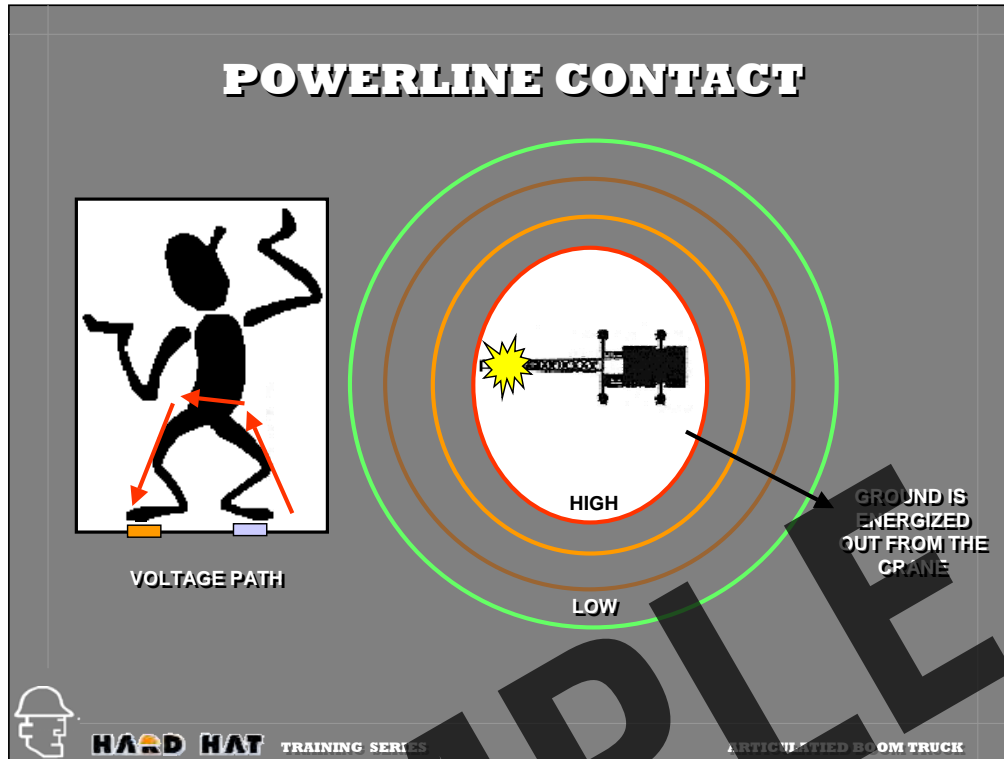


HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To review the requirements for operating around power lines.

1. The minimum clearance requirements need to be observed.
2. It may be necessary to have an assigned spotter to watch the crane boom to ensure that it does not enter the danger zone.
3. Electrocution is the number one cause of death involving cranes.

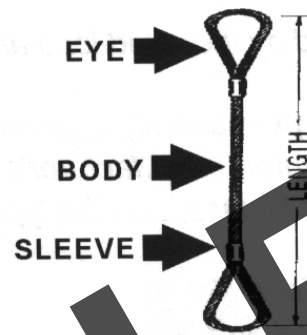


OBJECTIVE: To discuss what should be done in case of a power line contact.

1. The operator should remain with the crane if at all possible until the power company indicates it is safe to leave the crane. This is because the crane components could be at different voltage potentials and touching parts of the crane could result in being electrocuted.
2. No one should be allowed to approach the crane or to touch it. If the operator is unconscious, no attempt should be made to rescue him until the power company indicates it is safe to do so.
3. If the operator must leave the boom truck due to fire, he should shuffle to the edge of the platform he is standing on and carefully jump to the ground. It is important that he is able to land standing. Once on the ground, shuffle away from the boom truck.

WIRE ROPE SLING INSPECTION

KINKING
CRUSHING
UNSTRANDING
BIRDCAGING
STRAND DISPLACEMENT
CORE PROTRUSION
CORROSION
BROKEN OR CUT
STRANDS
BROKEN WIRES



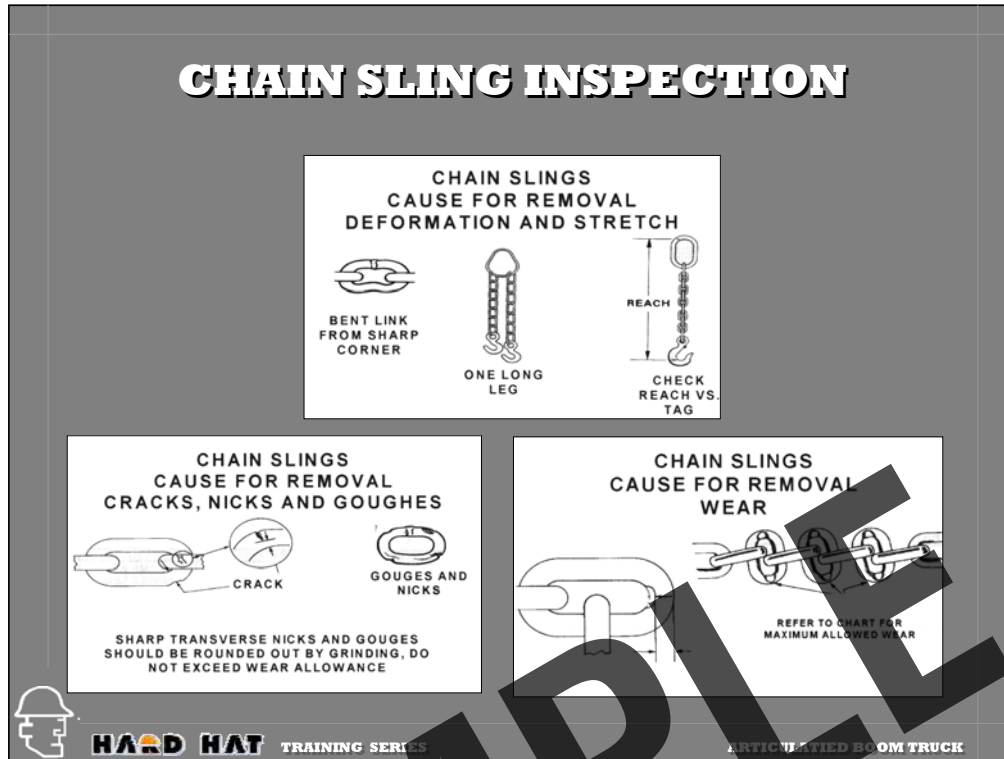
HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To review the requirements for inspecting wire rope slings.

1. Wire rope slings are to be inspected on a regular basis and a record kept of these inspections. Refer to the inspection card for inspection criteria.
2. As of July 2000 wire rope slings are to have a tag which indicates the lifting capacities of the sling for vertical, choker, and basket hitches.

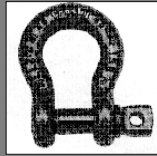
CHAIN SLING INSPECTION



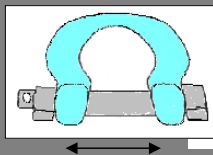
OBJECTIVE: To review the requirements for inspecting chain slings.

1. Chain slings are to be inspected on a regular basis and a record kept of these inspections. Refer to the inspection card for inspection criteria.
2. Chain slings are often used to hold steel while it is being welded. Always check to make sure no heat damage has occurred. Heat damage can be detected by discolored metal.

SHACKLES



TWO TYPES OF SHACKLES USED FOR LIFTING.



DEFORMATION



BOLT SUBSTITUTION



WEAR



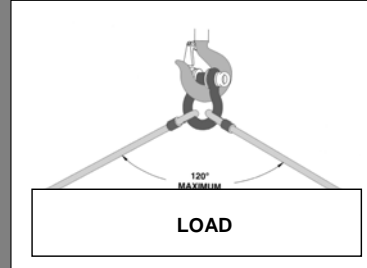
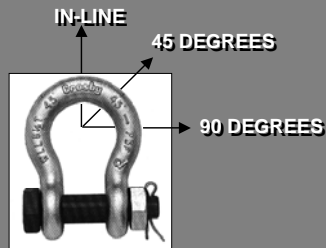
HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To discuss the inspection and use of shackles.

1. Only two type of shackles are to be used in rigging for lifts. The screw pin type and the bolt type shackle.
2. Shackles that are damaged or deformed must be removed from service.

SHACKLES



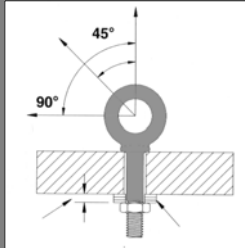
Angle of Side Load	Adjusted Working Load Limit
0° In-Line	100% of Rated Working Load Limit
45° from In-Line	70% of Rated Working Load Limit
90° from In-Line	50% of Rated Working Load Limit

† DO NOT SIDE LOAD ROUND PIN SHACKLES

OBJECTIVE: To show how the load rating of the shackle changes.

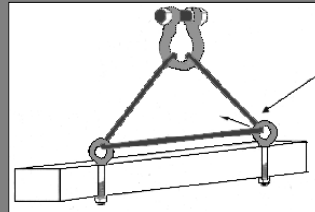
1. The working load limit, WWL, shown on the shackle is for vertical loads.
2. Round pin shackles are ones which do not have a nut on the end of the pin and should not be used for lifting.

EYE BOLTS



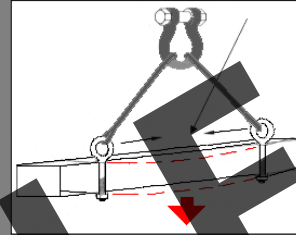
DIRECTION OF PULL	ADJUSTED WORKING LOAD
In-Line	Full Rated Working Load
45 Degrees	30% of Rated Working Load
60 Degrees	60% of Rated Working Load

WRONG!



DO NOT REEVE SLINGS ONE EYE BOLT TO ANOTHER. LOAD ON BOLT IS ALTERED.

CAUTION!



STRUCTURE MAY BUCKLE FROM COMPRESSION FORCES.



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To show how the load capacity of the eye dramatically change when loaded other than vertically.

1. The rated capacity of a eye bolt drops significantly when pulled other than vertically.
2. Emphasize the dramatic drop to the students.
3. Threading a sling through the eye bolts increases the stress on the eye bolts by two and should never be done.

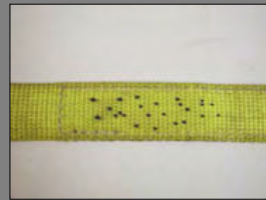
SYNTHETIC SLING INSPECTION



LOOSE STITCHING



HEAT DAMAGE



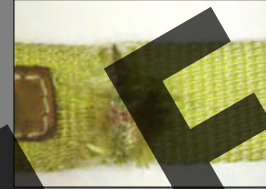
WELD SPLATTER



KNOTS



PUNCTURES



CUTS



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To review the requirements for inspecting synthetic slings.

1. This slide and the next two show the different types of sling damage that can occur. Refer to the inspection record of additional inspection criteria.
2. Synthetic slings are required to be inspected on a regular basis and a record kept of such inspections.

SYNTHETIC SLING INSPECTION



SCUFFING



RED THREADS



NICKS



MANUFACTURER TAG



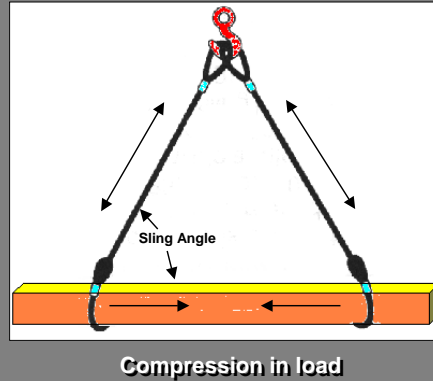
HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

Continuation of previous slide.

SAMPLE

SLING ANGLES



Tension in slings

Compression in load

Stresses in the slings and the load increase as the sling angle decreases

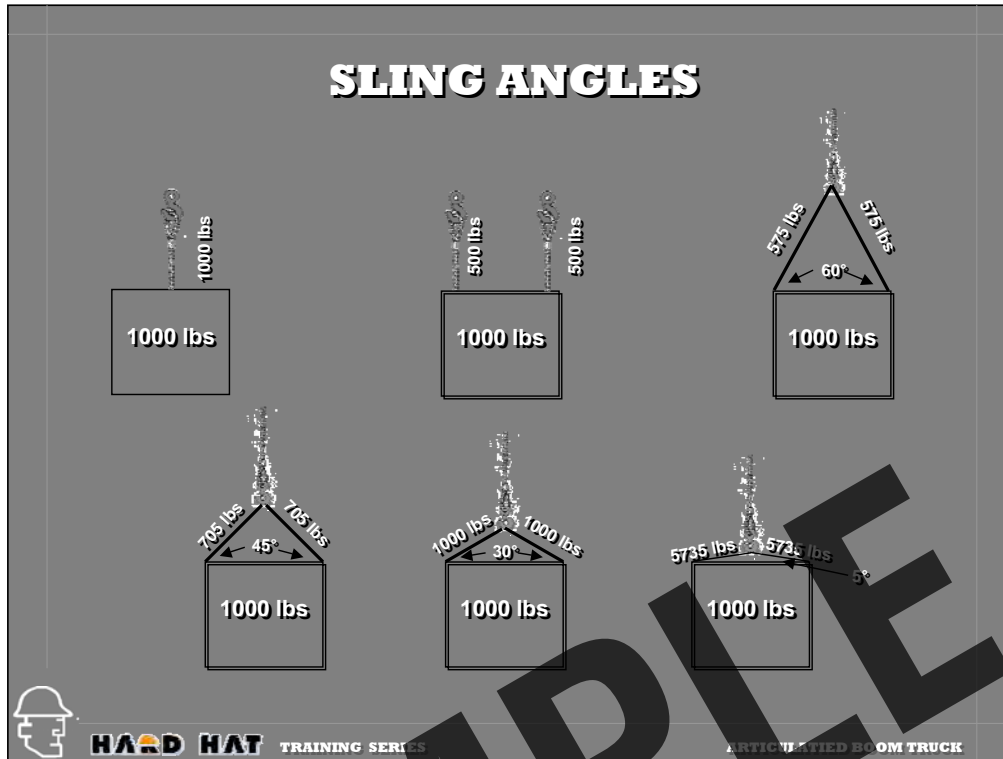


HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To review the basics of sling loading.

1. When slings are brought together and form a hitch arrange as shown above the stresses in the slings increase and a compression force on the load is created.
2. As the sling angle decrease the stresses in the sling and on the load increase.



OBJECTIVE: To show how the stress in the slings increase as the sling angle decreases.

1. Review each of the different sling angle configurations and point out the increase in the stresses.
2. Sling angles of 60 degrees are the best to use because of the minimal increase of stress in the slings. When required to use smaller sling angles, slings need to be selected based on the increased stress and not on the weight of the load.
3. When the sling angle is 30 degrees for a 1000 lbs load, the compression loads which are crushing the load will be 866 lbs. Depending on the structural strength of the load, it may be damaged.

SLING ANGLES

Sling Angle Degree (A)	Load Angle Factor = L/H
90	1.000
60	1.155
50	1.305
45	1.414
30	2.000

Load On Each Leg Of Sling = (Load / 2) X Load Angle Factor

HARD HAT TRAINING SERIES
 ARTICULATED BOOM TRUCK

OBJECTIVE: To show how the stresses in the slings can be determined.

1. All that is need to calculate these stress is the weight of the object and a measuring tape.
2. As shown in the slide above, the length of the sling is divided by the height of the sling connection to the top of the load.
3. The answer is then multiplied by the portion of the load it is to support and this will be the stress in the sling.

Example: If my sling was 8 feet long and the height 'H' was 4 feet, 8 divided by 4 equals 2. The portion of the weight the sling is to support is half of 1000 lbs or 500 lbs. 2 X 500 = 1000 lbs which is the stress in the sling.

ESTIMATING WEIGHTS

Acceptable methods of determining weight

You may find the weight from:

- Data on manufacturing label plates.
- Manufacturer documentation.
- Blueprints or drawings.
- Shipping receipts.
- Weigh the item.
- Bill of lading (be careful)
- Stamped or written on the load
- Approved calculations

Never use word of mouth to establish the weight of an item!



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To show the different means of determining the weight of a load.

ESTIMATING WEIGHTS

Calculating the weight

To find the weight of any item you need to know its volume and unit weight.

- Volume x Unit weight = Load weight
- Unit weight is the density of the material
- Unit weight is normally measured by pounds per cubic foot.



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To emphasize the importance of knowing how to calculate weights.

SAMPLE

ESTIMATING WEIGHTS

Here are some examples of common materials and their unit weight:

(POUNDS PER CUBIC FOOT)

METALS		TIMBER	
Aluminum	165	Cedar	34
Brass	535	Cherry	36
Bronze	500	Fir, seasoned	34
Copper	560	Fir, wet	50
Iron	480	Hemlock	30
Lead	710	Maple	53
Steel	490	Oak	62
Tin	460	Pine	30
MASONARY		Poplar	30
Ashlar masonry	160	Spruce	28
Brick, soft	110	White pine	25
Brick, pressed	140	Railroad ties	50
Clay tile	60	LIQUIDS	
Rubble masonry	155	Diesel	52
Concrete, cinder, haydite	110	Gasoline	45
Concrete, slag	130	Water	64
Concrete, stone	144	EARTH	
Concrete, reinforced	150	Earth, wet	100
MISC.		Earth, dry	75
Asphalt	80	Sand and gravel, wet	120
Glass	160	Sand and gravel, dry	105



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To show the unit weights for some common materials.

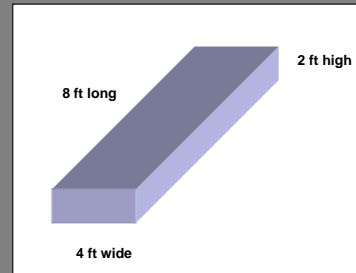
1. It's wise to have similar "cheat sheets" for materials that you handle frequently.

CALCULATING VOLUME

Volume of a cube

Length x Width x Height = Volume

8 ft x 4 ft x 2 ft = 64 cubic feet



If the material was cedar, then all we would have to do to determine its weight would be to multiply the unit weight of cedar x 64.

Unit weight x Volume = Weight

34 lbs. X 64 cubic ft. = 2,176 lbs.



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To demonstrate how to calculate the volume of a cube.

1. Cubes are easy to calculate.
2. Finding the weight is as simple as multiplying the volume of the cube by the unit weight of what it is made of.

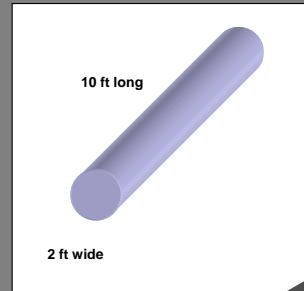
CALCULATING VOLUME

Volume of a cylinder

$\text{Pi} \times \text{Radius Squared} \times \text{Length} = \text{Volume}$

$\pi \times \text{Radius}^2 \times \text{Length} = \text{Volume}$

$3.14 \times 1^2 \text{ ft} \times 10 \text{ ft} = 31.4 \text{ cubic ft}$



If the material was reinforced concrete, then all we would have to do to determine it's weight would be to multiply the unit weight of reinforced concrete x 31.4.

150 lbs. X 31.4 cubic ft. = 4,710 lbs.



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To demonstrate how to find the volume of a cylinder.

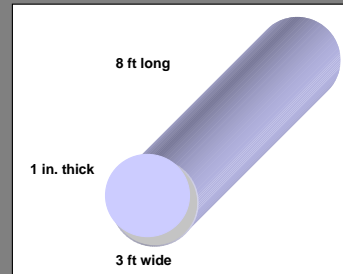
1. The volume of a cylinder is a little more difficult, but not rocket science. Having a scientific calculator and knowing how to use it is a good idea.
2. Again, just multiply the volume in cubic feet by the unit weight to find the weight of the load.

CALCULATING VOLUME

Volume of pipe

Calculating the volume of pipe is a bit trickier but it is just simply subtracting the volume of the hole from the volume of the pipe.

If the pipe were one inch thick, three feet wide and 8 feet long, then we would figure the volume of the entire pipe and subtract the volume of the hole to get the volume of the material.



$$3.14 \times (1 \frac{1}{2} \text{ ft.})^2 \times 8 \text{ feet} = \text{total volume of pipe (56.52 ft}^3\text{)}$$

$$3.14 \times (1 \text{ft } 5 \text{ in.})^2 \times 8 \text{ feet} = \text{volume of hole (50.41 ft}^3\text{)}$$

$$56.52 \text{ ft}^3 - 50.41 \text{ ft}^3 = 6.11 \text{ ft}^3$$

Volume of material x unit weight = total weight

If this pipe were steel then the unit weight would be 490 lbs.

$$6.11 \times 490 \text{ lbs} = 2,994 \text{ lbs.}$$



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To demonstrate how to find the volume of a pipe.

1. Finding the volume of a pipe is not too much different than finding the volume of a cylinder. You just have to do it twice and then subtract the volume of the hole from the total volume of the pipe.
2. It is helpful to know how to change fractions into decimals. Calculators are a must for this. To change 1 foot 5 inches (or 17/12ths) into a decimal, simply divide 12 into 17 which would be 1.4266.

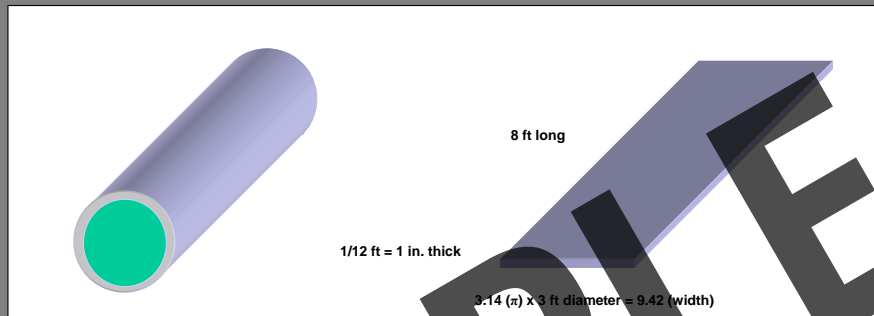
CALCULATING VOLUME

For thin pipe a quick way to ***ESTIMATE** the volume is to split the pipe open and calculate the volume like a cube. The formula would be:

$\pi \times \text{diameter} = \text{width}$, so:

$\pi \times \text{diameter} \times \text{length} \times \text{thickness} \times \text{unit weight} = \text{weight of object}$

$3.14 \times 3 \text{ ft} \times 8 \text{ ft} \times 1/12 \text{ ft (or .08 ft)} \times 490 \text{ lbs} = *3,077.2 \text{ lbs}$



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To demonstrate how to estimate the volume of thin pipe.

1. This is only an estimate and should not be used with thick pipe.
2. Simply spit the pipe down the middle and open it up into a thin plate.
3. Then calculate the the volume of the cube that is created.
4. To find the width, multiply pi times the diameter.

WEIGHT TABLES

WEIGHT TABLES

Weight tables are an excellent way to calculate load weight. If you are handling certain materials often, then having a chart that gives you the weight per cubic foot, cubic yard, square foot, linear foot or per gallon. Here are a few examples:

METAL PLATES

STEEL PLATES weigh approximately 40 lbs per sq. ft. at 1 inch thick. 1/2 inch thick would then be about 20 lbs. per sq. ft.

A steel plate measuring 8 ft. x 10 ft. x 1/2 inch would then weigh about 3,200 lbs. (8 x 10 x 40 lbs = 3,200 lbs.)

BEAMS

Beams come in all kinds of materials and shapes and lengths. STEEL I-BEAMS weigh approximately 40 lbs a linear ft. at 1/2 inch thick and 8 inches x 8 inches. If it were 1 inch thick then it would be 80 lbs a linear ft. If it were 20 feet long at 1 inch thick then it would weigh about 1,600 lbs. (20 ft. x 80 lbs. = 1,600lbs.)



HARD HAT TRAINING SERIES

ARTICULATED BOOM TRUCK

OBJECTIVE: To encourage the use of weight tables for determining the weights of loads.

SAMPLE