

Chapter 7

Cranes

Cranes are used to hoist and place loads. They are mounted in one of three ways—truck, crawler, or rough-terrain (wheel). The truck and rough-terrain mounts do not provide the stability of the crawler mount. Attaching accessory equipment to the crane's superstructure and boom allows use of the basic machine for pile driving or as an excavator.

BASIC CRANE UNIT

7-1. The basic crane unit (*Figure 7-1*) consists of a substructure mount and a full revolving superstructure. The upper revolving superstructure is substantially the same without regard to the substructure mount. Installing attachments allows use of the machine for tasks other than hoisting. *Figure 7-2, page 7-2*, shows several crane attachments—hook block, clamshell, pile driver, and dragline.

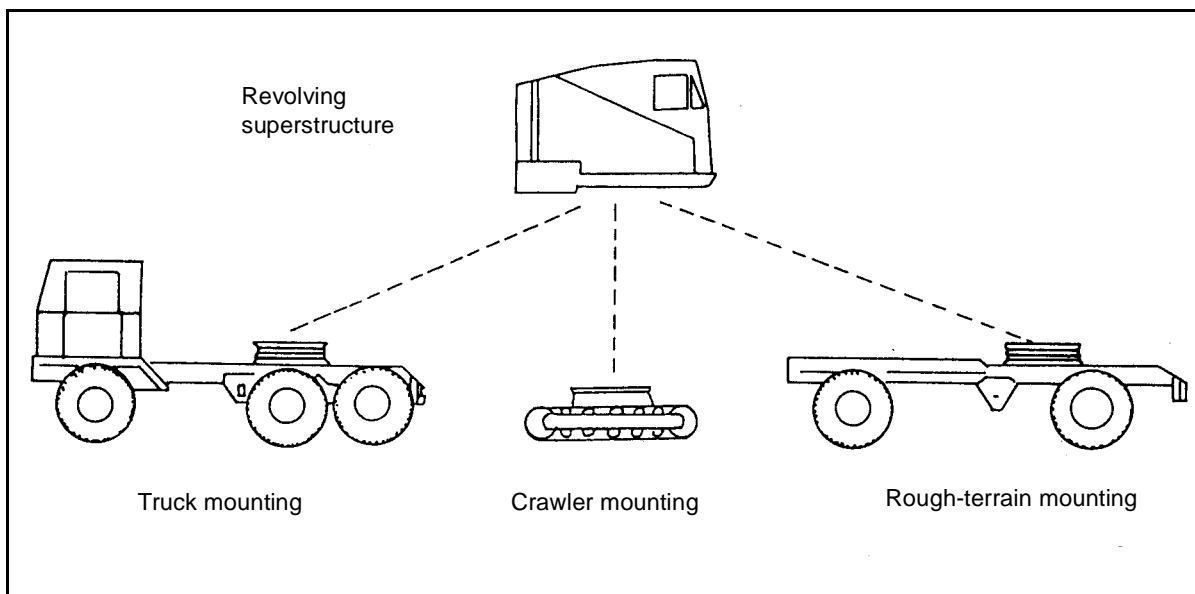


Figure 7-1. Basic Crane Unit

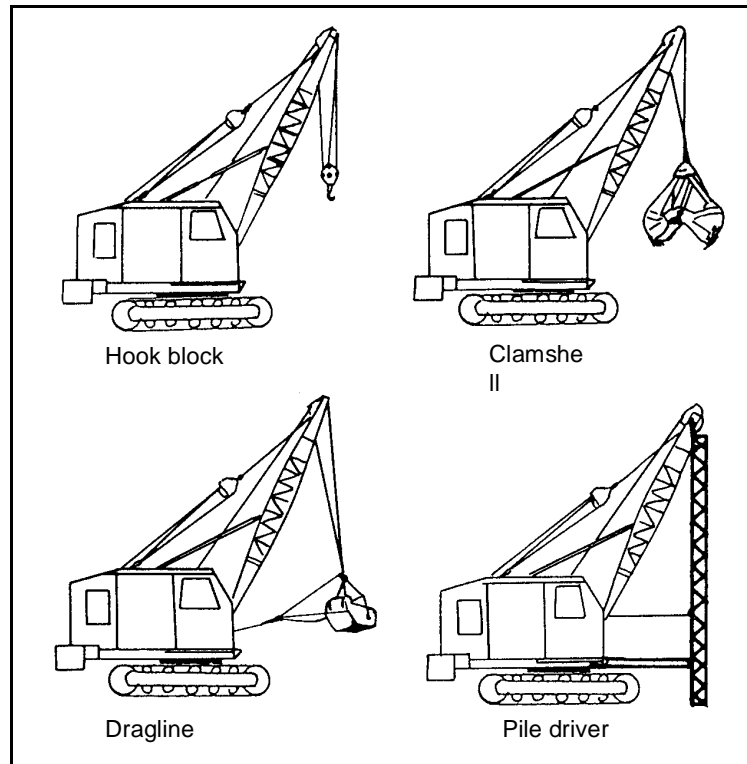


Figure 7-2. Crane Attachments

SUBSTRUCTURE

7-2. The substructure can be a truck, a crawler, or a rough-terrain mount. Each mount has different stabilization and terrain capabilities.

Truck Mount

7-3. Truck cranes have specially-designed heavy-duty truck mounts. This mounting provides good between-project mobility. The 20- and 25-ton truck cranes can operate a hook block, a 0.75-cubic-yard clamshell, a 7,000-foot-pounds-per-blow diesel pile driver, or a dragline. *Figure 7-3* shows a 25-ton truck crane with a hydraulic telescopic boom.

- **Stability.** These cranes have outriggers on each side. Always employ the outriggers when operating the crane or attachments. Fully extend the outriggers and secure the jacks on the base plates so that the crane is completely off of the tires. Some models are equipped with hydraulic outriggers.
- **Terrain capability.** Because of its limited stability, the truck mount restricts the efficient movement of these cranes to firm, level terrain.

7-4. **Towing.** A pintle hook (towing connection) is on the rear of the truck, and towing eyes are on the front. The pintle hook enables the truck to tow an attachment trailer for transporting associated attachments to the job site. If the truck becomes inoperable or stuck, use the towing eyes to attach the truck to a towing vehicle. The towing eyes will withstand twice the dead-weight pull of the vehicle.

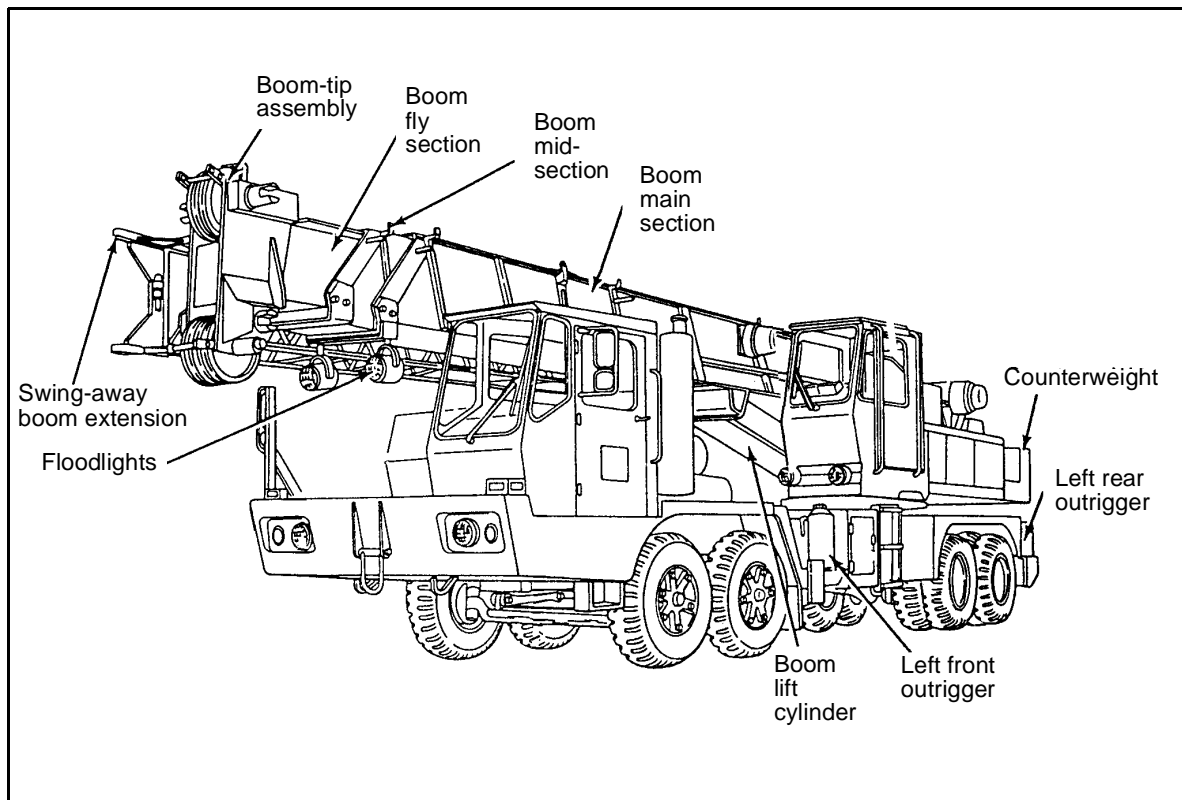


Figure 7-3. Truck Crane (25-ton) With a Hydraulic Telescopic Boom

7-5. Operating Hints.

- Be sure the crane is level prior to operating.
- Do not hoist loads over the front. Generally, perform all heavy hoisting over the rear of the truck since the truck's cab and engine provide additional counterweight for the load. When using a load chart, ensure that the capacity reflects the quadrant of the proposed hoist. For example, over the side, over the rear of the mount, or over the front of the mount.
- Use the outriggers.
- Check the base plates periodically to ensure that good soil bearing is being maintained.
- Place the truck's transmission in neutral when operating the superstructure. This prevents possible damage to the gears by any rocking movement of the truck.

Crawler Mount

7-6. Move crawler cranes from project to project on transport trucks. Crawler cranes have relatively low travel speeds, and long travel causes excessive track wear. Crawler cranes are best suited for longer duration jobs. The crawler mount provides excellent maneuverability on the job site and has low ground-bearing pressure. The 40-ton crawler crane can operate a hook block, a

2-cubic-yard clamshell, a 24,000-foot-pounds-per-blow diesel pile driver, or a dragline. The military normally uses the 40-ton crane in quarry operations.

- **Stability.** The crawler mounting provides a stable base for operating the revolving superstructure. Because of the width and length of the crawler tracks, the weight of the machine spreads over a large area.
- **Terrain capability.** Crawler cranes are designed to operate on level ground. A 3° out-of-level condition can result in a 30 percent loss in hoisting capacity. Crawler cranes' low ground-bearing pressure enables them to travel over soft ground. In locations where the ground is extremely soft or unstable, use timber mats to provide a firm footing (*Figure 7-4*). When not handling a load, the machine can climb slight grades.

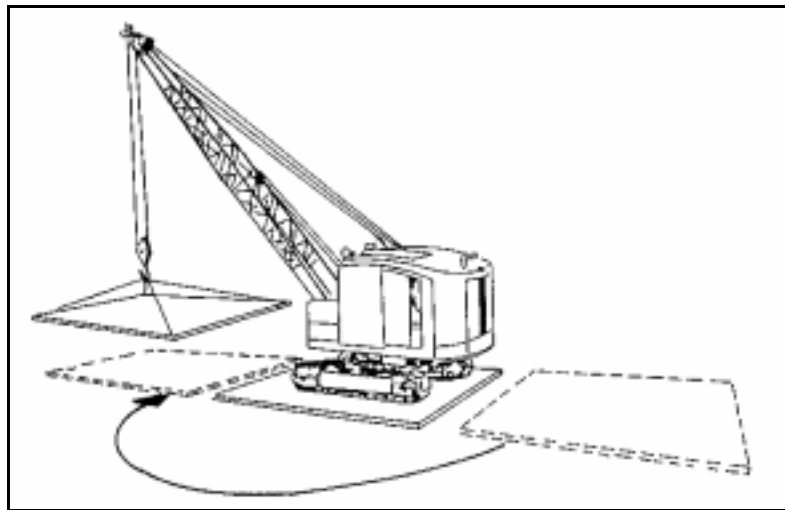


Figure 7-4. Timber Mats Supporting a Crawler Crane on Soft Material

7-7. Crawler cranes can be lashed on barges to operate over water. They can operate in shallow water as long as the water does not enter the revolving superstructure. Before moving the machine into the water, check the water depth and the under-foot conditions. Thoroughly clean and service the machine after working in salt water.

Rough-Terrain Mount

7-8. The two models of rough-terrain cranes are the 22- and the 7.5-ton (Type I, general purpose, and Type II, airborne/airmobile). The 22-ton rough-terrain crane can operate a hook block, a 0.75-cubic-yard clamshell, a 7,000-foot-pounds-per-blow diesel pile driver, or a dragline. The main differences between the rough-terrain crane and the truck crane are the large tires and the high ground clearance, which enables the rough-terrain crane to work in areas inaccessible to the truck crane.

7-9. **Rough-Terrain Crane (22-Ton).** The rough terrain crane has the capability of long-distance highway travel and good job-site maneuverability. The mount provides four-wheel-drive capability, conventional two-wheel steering, four-wheel steering, and crab steering. The travel speed of the machine is 55 mph on the highway. This crane has dual cabs, a lower cab for

highway travel, and a superstructure cab that has both the drive and the crane controls. A pintle hook on the rear of the mount lets it tow an attachment trailer. However, towing the trailer cross-country is not recommended.

- **Stability.** Since the mount is not suspended on springs, the front axle must oscillate. This oscillation prevents the mount from tipping or rolling over if one of the front wheels drops into a hole. Use the outriggers to raise the machine off the ground and to level it before extending the boom. If using outriggers to stabilize the machine, position safety wedges on the front axle to prevent oscillation. The outriggers operate individually, allowing the superstructure to be leveled. Load ratings are based on the assumption that the crane is in a level position for the full 360° of swing.
- **Terrain capability.** The machine's low ground-bearing pressure lets it travel over relatively soft terrain. It can traverse slopes up to 48 percent if the ground is firm and dry.

7-10. **Rough-Terrain Crane (7.5-Ton).** The basic 7.5-ton rough-terrain crane (Type I) has a diesel engine, pneumatic tires, two- and four-wheel-drive capability, and two- and four-wheel-steering capability. The cab is located on the mount instead of on the full 360° rotating superstructure. It has a hydraulic boom that is extendible from 28 feet to a maximum of 35 feet. This crane can perform lifting and carrying operations (desirable with standard North Atlantic Treaty Organization [NATO] pallets). The rough-terrain, 7.5-ton airborne crane (Type II) (*Figure 7-5*) is a modification of the basic 7.5-ton unit, making it suitable for airborne and airmobile operations.

- **Stability.** The rough-terrain mount has four independently operated outriggers (two on each side).
- **Terrain capability.** This crane can safely traverse typical construction terrain, longitudinal grades of 30 to 50 percent, and side slopes of 15 to 30 percent in four-wheel drive. This crane can be used on firm terrain because of its high ground-bearing pressure tires.

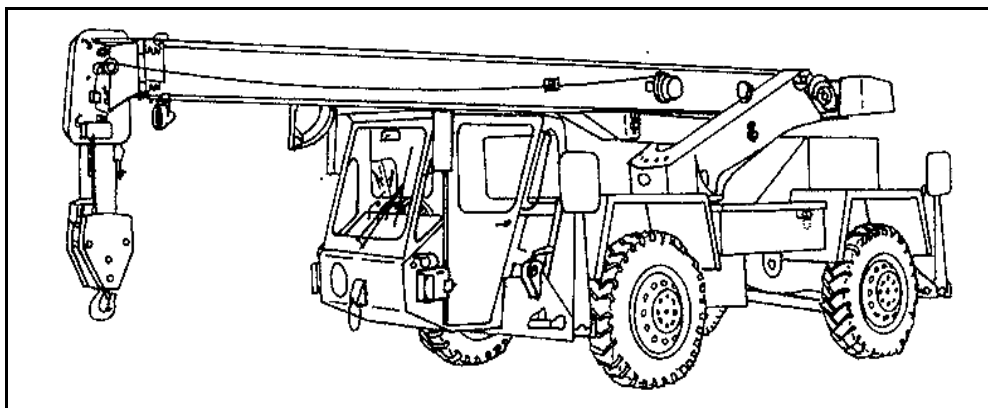


Figure 7-5. Rough-Terrain, 7.5-Ton Airborne Crane

SUPERSTRUCTURE

7-11. The revolving superstructure rests on the mount and includes the counterweight, the engine, the operating mechanism, the boom, the cab, and sometimes a separate engine.

Counterweight

7-12. The counterweight is normally a cast-steel member attached to the rear of the superstructure to produce a countermoment to the weight and radius of the load. This countermoment prevents the crane from tipping.

Operating Mechanisms

7-13. Two independent cable drums control the operation of the various attachments. The drums are mounted parallel to each other or one behind the other. Refer to them by their relative mounting (*right* or *left*, *front* or *rear*) or by their function (*drag cable drum* during dragline operations or *closing-line cable drum* during clamshell operations). When using the drums in conjunction with a hook block, refer to them as the *rear* or *main hoist drum*.

7-14. A third cable drum, the *boom hoist drum*, controls the raising and lowering of the boom for those cranes having a lattice boom. Some models have a two-piece, grooved lagging for quick attachment to the drum shaft. The diameters of the grooved lagging differ depending on the make and model of the machine. Differences in lagging diameter provide different operating line speeds. For example, the lagging used for dragline operations may be smaller to provide a slower line that gives greater power.

7-15. Clutches and brakes may be powered mechanically, hydraulically, or pneumatically. Some makes and models have an internally mounted clutch that, when actuated, expands to engage the drum. Other makes and models have external contracting clutches.

Boom

7-16. **Lattice Boom.** The lattice boom is a latticed structure consisting of four main chords connected with lacing. The basic boom consists of a base section supported on the revolving superstructure and an upper section with a boom head. The sections are fastened together by one of two methods—bolted butt-plate (flange) connections or pin and clevis connections. The length of a lattice boom can be increased in one of two ways—inserting an intermediate section between the upper and base sections (the most common way) or adding a boom tip extension called a jib. A jib is a lighter structural section. An offset jib permits greater load radius than an equivalent length of standard boom. Crane booms not equipped with jib-boom anchor plates can only use intermediate sections for extending the boom. When lengthening lattice booms, extend the gantry or A-frame to provide the required lifting angle for the boom lines.

7-17. **Hydraulic Telescopic Boom.** This boom consists of two or more telescoping boxes made of steel plates. The action of hydraulic cylinders extends or retracts the boxes. Only certain attachments can be used with these booms. This boom type is used on some rough-terrain cranes and truck cranes (*Figure 7-3, page 7-3*).

HOISTING OPERATIONS

7-18. The hook block (*Figure 7-2, page 7-2*) used for hoisting operations is applicable on either a lattice or a telescoping boom. Basic crane equipment includes hoist drums, hook blocks to provide the required parts of line (reeving), and boom-suspension and hoist cables.

FACTORS AFFECTING HOISTING CAPACITY

7-19. Boom length, operating radius or boom angle, type of mount, stability (use of outriggers), amount of counterweight, hook-block size, hoisting position, and maintenance determine the crane's safe hoisting capacity.

Boom Length

7-20. Increased boom length reduces a crane's hoisting capacity. Use of a jib attachment will further reduce the hoisting capacity. The increased load moment at the greater operating radius and the added weight of the additional boom sections decrease the hoisting capacity.

Operating Radius

7-21. Operating (working) radius (*Figure 7-6*) is the horizontal distance measured from the axis of rotation of the superstructure to a vertical line extending down from the outside edge of the crane's boom-tip (head) sheave. Cranes are rated according to hoisting capacities at various radii, based on either tipping or structural constraints. Swinging the boom causes a centrifugal force (*Figure 7-7, page 7-8*), which in effect increases the operating radius. High winds can also push the load, which increases the operating radius (*Table 7-1, page 7-8*). As the working radius increases, the hoisting capacity decreases. It is essential to know the weight of a load before hoisting.

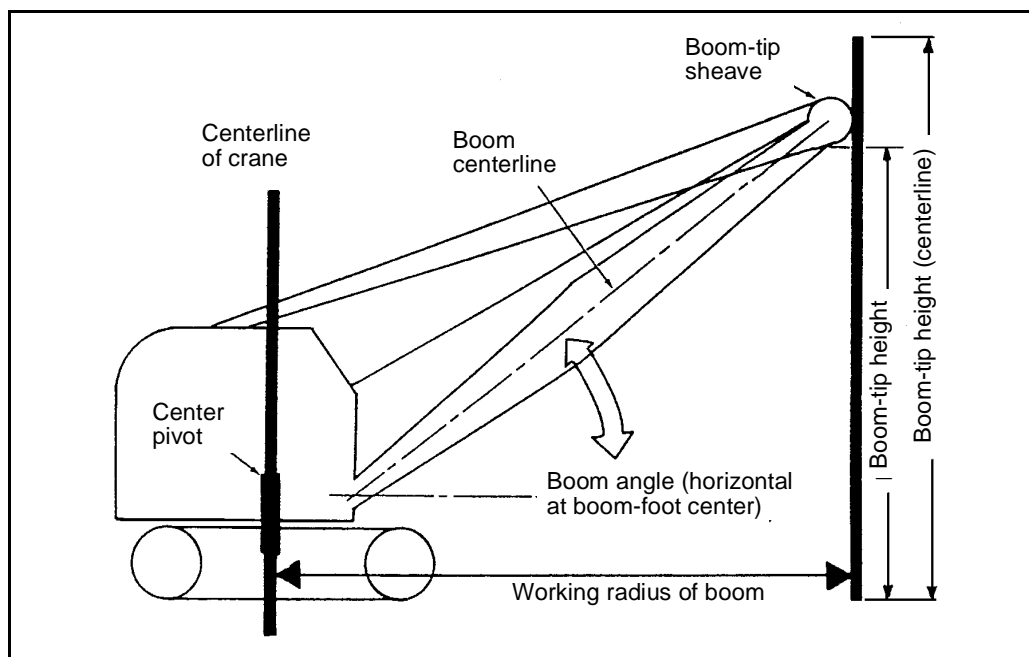


Figure 7-6. Operating Radius of a Boom

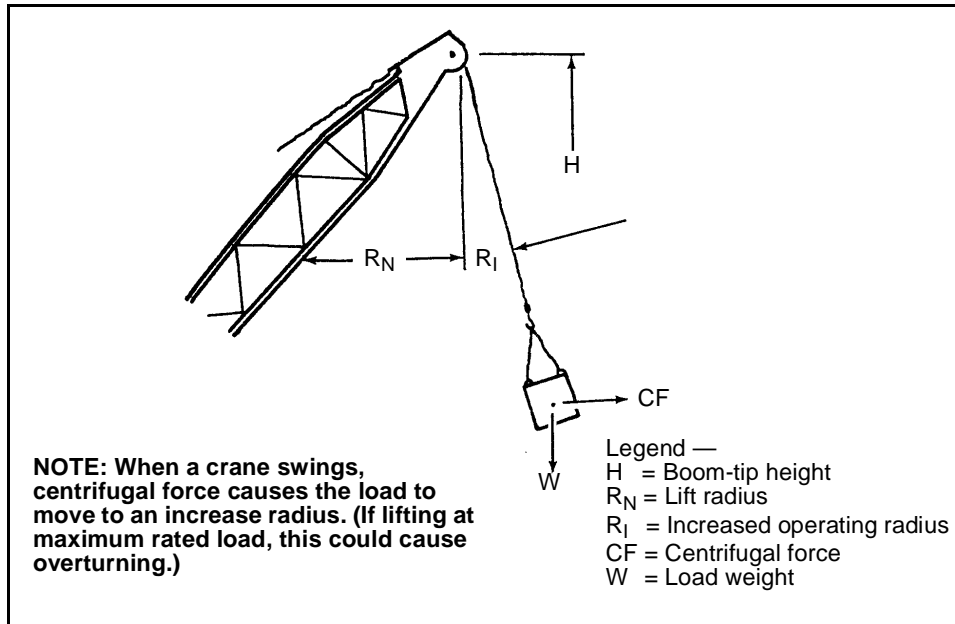


Figure 7-7. Effects of Centrifugal Force on the Operating Radius

Table 7-1. Effects of Wind on Crane Operations

Approximate Wind Speed		Weather Conditions	Effects
mph	kph		
0-1	0-1.5	Calm	Smoke rises straight up
1-3	1.5-5	Light air	Smoke drifts
4-7	6-11	Slight breeze	Leaves rustle
8-12	12-19	Gentle breeze	Leaves and small twigs move
13-18	20-29	Moderate breeze	Dust and papers fly; small branches move
19-24	30-39	Fresh breeze	Small trees sway
25-31	40-50	Strong breeze	Large branches move
32-38	51-61	High wind	Walking is difficult; tree trunks bend
39-46	62-74	Gale	Twigs break off
47-54	75-87	Strong gale	Shingles are blown away
55-63	88-100	Whole gale	Trees may be uprooted

Mount Type

7-22. The basis of a crane’s hoisting-capacity rating concerning tipping is as follows (check the operator's manual for the correct table):

- **Crawler mounted.** Power Crane and Shovel Association (PCSA) standards limit the load capacity concerning tipping to 75 percent of the maximum load.
- **Truck and rough-terrain mounted.** PCSA standards limit the load capacity concerning tipping to 85 percent of the maximum load whether on tires or outriggers.

Capacity at short radii is usually limited by the structural capacity of the machine's components. In the case of hydraulic cranes, the hydraulic capacity sometimes limits the lifting capability.

Stability

7-23. It is extremely important that the crane be positioned on a firm, level footing and, if outriggers are available, that they be fully extended and bearing. If necessary, prepare the crane's operating site in advance. Adherence to a machine's load-chart ratings ensures that the crane is stable in terms of a moment balance between load weight and radius and the machine's counterweight. A crane's hoisting ability as presented in the load chart assumes that the machine is positioned on solid, level ground. Take care not to position the crane's tracks or outriggers over underground utilities or recompacted trench excavations or close to excavation edges, all of which could give way when hoisting a load.

Counterweight

7-24. Do not add additional counterweight or anchor the crane to a *deadman* in an attempt to increase hoisting capacity. These procedures could cause structural damage to the crane.

Hook-Block Size

7-25. The hook block on the crane should be the size prescribed for the crane. Lack of proper rigging and hook capacity may damage the block and the sheave system. Tables of hoisting capacities are based on gross capacity; therefore, the weight of the hook block and slings must be considered as part of the load.

Hoist Position

7-26. The load capacity of a crane depends on the quadrant position of the boom with respect to the machine's undercarriage. In the case of a crawler crane, consider three quadrants; over the side, over the drive end of the tracks, and over the idler end of the tracks. Usually, imaginary lines from the superstructure's center of rotation through the position of the outriggers define the quadrants for mobile cranes. Always consider the minimum condition based on swinging the load from point of pick up to final placement.

Maintenance

7-27. Proper crane maintenance will help to achieve rated, safe hoisting capacity. Check the following items to ensure that the crane can attain its rated hoisting capacity:

- Type, size, and condition of the wire ropes.
- Type, size, and condition of the hook block.
- Structural condition of the boom.
- Mechanical condition of the engine.
- Adjustments and functional qualities of the clutches and brakes.

SAFE HOISTING-CAPACITY CALCULATION

Step 1. Determine the required clearance (*Figure 7-8*), which includes the—

- Load height.
- Hoisting height.
- Hook-block height.
- Minimum, estimated safe distance between the boom-tip sheave and the hook-block sheave. (This is a judgment call; normally, a 2-foot clearance is satisfactory.)
- Height of the slings from the load's top to the hook.

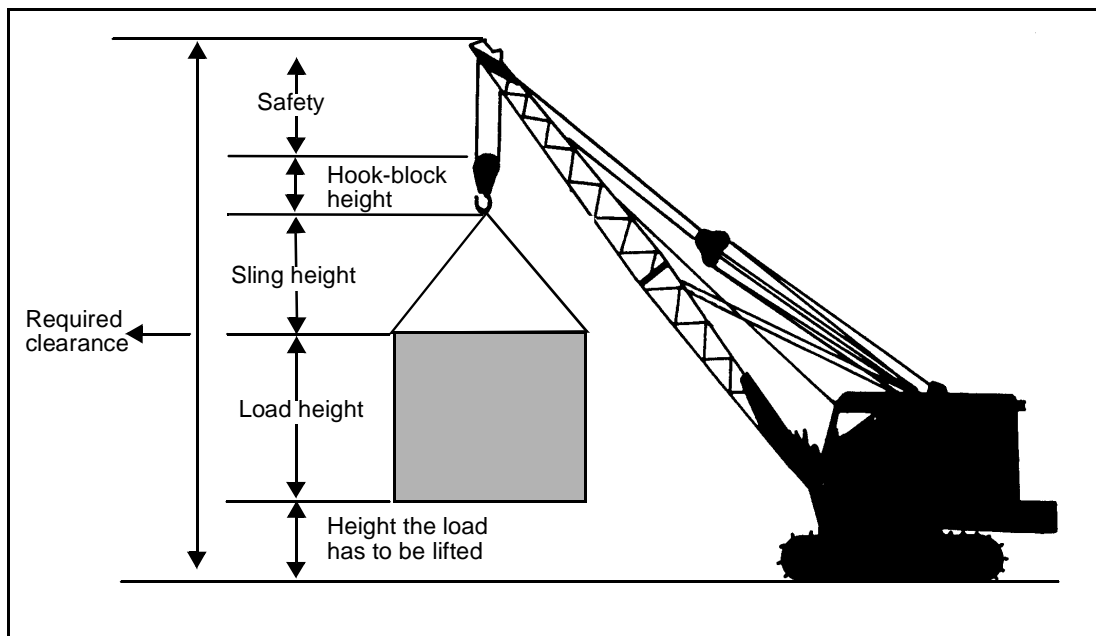


Figure 7-8. Required Clearance

Step 2. Determine the total weight to hoist, which includes the—

- Load weight.
- Hook-block weight.
- Sling weight.
- Stowed jib weight (if mounted on the boom).

Step 3. Determine the working radius. This is the distance from the crane's center of rotation to the load's center. Always consider the maximum radius that results when swinging the load from point of pick up to final placement.

NOTE: Remember that centrifugal force (caused by swinging the boom or from the wind) can increase the radius. Refer to *Figure 7-7, page 7-8, and Table 7-1, page 7-8, respectively.*

Step 4. Determine if the crane will hoist the load. Use the appropriate equipment-hoisting charts and the following information:

- Boom length.
- Boom angle.
- Boom-tip height.
- Total hoisted weight.

OPERATION TIPS

- Try to position the crane to eliminate swinging over workers.
- Ensure that the supporting ground has adequate strength.
- Position the crane for the shortest possible boom swing and swing the load slowly when performing repetitive hoisting.
- Ensure that the machine is always level.
- Use tag lines on loads to prevent excessive swaying of the load.
- Use adequate hoist-line lengths to ensure full travel of the block to the lowest point required.
- Organize the work for minimum travel time. When possible, complete all needed hoists in one area before moving to a new position.
- Use the power-down device on the equipment (if available) when performing precise load handling.
- Do not use excessive counterweight or tie-down devices to increase stability.
- Check weather reports or use the indicators given in *Table 7-1, page 7-8*, to determine approximate wind speed. Wind can affect crane operations and even cause overturning when hoisting close to or at maximum hoisting capacity. Cease work if wind speed exceeds 30 mph.

PILE DRIVER

DESCRIPTION

7-28. The pile driver attachment (see *Figure 7-2, page 7-2*) consists of adapter plates, leads, a catwalk, a hammer, and a pile cap. The adapter plates are bolted to the top section of the leads and fastened to the boom tip. The leads are fastened below the base of the boom. Pile leads cannot be attached to a jib boom. The hammer may be diesel or drop type.

Diesel Hammers

7-29. Diesel-driven, pile-driving hammers come in two types—open-top or closed-end. Both types have self-contained, free-piston engines, operating on a two-cycle compression-ignition principle. Diesel hammers eliminate the need for air compressors or steam boilers to power the hammer. Do not use these hammers to pull piles. They are suitable for use on either lattice or telescopic booms. When driving a pile in soft soil, a diesel hammer may not fire because there is insufficient soil resistance to support fuel ignition. When this happens, revert to a drop hammer until the pile reaches sufficient driving resistance.

Drop Hammers

7-30. Gravity-operated drop hammers are best for driving vertical piling. When piling is angled, part of the driving force is lost in friction with the pile leads. Drop hammers are relatively slow compared to other types of hammers. Use a hammer that is at least as heavy as the pile being driven; for best results, the hammer should be twice as heavy as the pile. It is better to use a heavier hammer with a smaller drop. Raise and drop the hammer at a steady rate of speed. Typical drop rates are four to eight blows per minute. The recommended drop height varies with the type of pile; for example, the recommended drop height is 15 feet for timber piles and 8 feet for concrete piles.

DRIVING RATE

7-31. Driving time varies greatly depending on the terrain, the weather, the soil conditions, the type of pile, and the type of hammer used. The only way to determine the driving rate is to drive a pile under project conditions. A rule of thumb to use for planning is 30 minutes to drive a 12-inch diameter pile 20 feet. This includes the time for setting the pile in the leads.

OPERATION TIPS

7-32. Use the following guidelines when operating a pile driver:

- Position the crane so that it will require the minimum time to move between pile locations. Placement is generally parallel to the long axis of the pile group.
- Place the piles close to the driving locations so that the crane only needs to swing to pick up the next pile.
- Make shallow, continuous blows with the hammer. High, infrequent blows cause pile failures.

CLAMSHELL

DESCRIPTION

7-33. The clamshell (see *Figure 7-2, page 7-2*) consists of a clamshell bucket, hoist drum laggings, a tag line, and wire ropes for the boom. The clamshell bucket consists of two scoops hinged together. A clamshell cannot be operated off of a jib. Clamshell drum laggings may be the same as those used for the crane, or they may be changed to meet the speed and pull requirements of the clamshell. This requirement may change with the design of the equipment (check the operator's manual). Usually, the same wire ropes used for hoisting operations can be used for clamshell operations. However, two additional lines must be added—a secondary hoist line and a tag line. The tag line is a small-diameter cable with a spring-tension winder that is used to prevent the clamshell bucket from twisting during operation. The tag line and winder, like the clamshell bucket, are interchangeable with any make or model in the same size range. The spring-loaded tag line does not require operator control and does not attach to the crane's operating drums. The winder is usually mounted on the lower part of the boom.

7-34. The clamshell is a vertically-operated attachment capable of working at, above, and below ground level. Attach the clamshell bucket to the crane's hoist line. A clamshell can dig in loose to medium-stiff soils. The length of the

boom determines the height a clamshell can reach. The length of wire rope the cable drums can accommodate limits the depth a clamshell can reach. A clamshell's hoisting capacity varies greatly. Factors such as the boom length, the operating radius, the size of the clam bucket, and the unit weight of the material excavated determine a clamshell's safe hoisting capacity. Refer to the crane's load-capacity table in the operator's manual.

USE

7-35. The clamshell is best for jobs such as excavating vertical shafts or footings or for charging aggregate bins or hoppers. The holding, closing, and tag lines control the bucket movement. At the start of the digging cycle, the bucket is dropped on the material to be dug with the shells open. As the closing line is reeved in, the shells are drawn together causing them to dig into the material. The weight of the bucket, which is the only crowding action available, helps the bucket penetrate the material. The holding and closing lines then raise the bucket. Release the tension on the closing line to open the bucket and dump the material.

Excavating Vertical Shafts or Footings

7-36. Since the dimensions of this type of excavation may vary, it is difficult to give the most efficient digging position for the clamshell. Two important facts to consider are the amount of wire rope on the machine and the need to keep the outside edge of the cut lower than the center (this keeps the bucket from drifting toward the center and causing a V-shaped excavation). In deep excavations, a bucket spotter or signalman usually guides the operator, especially when the bucket is out of the operator's sight. Spotters may also need to use hand tag lines to guide the bucket.

Charging Aggregate Bins or Hoppers

7-37. Position the crane to avoid having to raise and lower the boom when swinging between the aggregate stockpiles and the bins or hoppers.

PRODUCTION ESTIMATES

7-38. The following factors make it difficult to arrive at dependable clamshell production rates:

- The difficulty of loading the bucket in different soil types.
- The height to hoist the load.
- The slow swing required.
- The method of disposing of the load.

For example, when loading material into a truck, the time required to spot the bucket over the truck and dump the load is greater than when dumping the material onto a spoil pile. The best method for estimating production is to observe the equipment on the job and measure the cycle time. Use the formulas in steps 1 through 5 shown in the following example when cycle-time data is available.

EXAMPLE

Determine the number of hours it will take to load 450 LCY of aggregate from a stockpile into haul units with a clamshell.

Bucket size = 0.75 cubic yard

Average cycle time = 40 seconds

Efficiency factor = 50-minute working hour

Step 1. Determine the bucket size.

Bucket size = 0.75 cubic yard

Step 2. Determine the working time (in seconds per hour). Convert working minutes per hour to working seconds per hour.

Working time (seconds per hour)

= **working minutes per hour** × **60 seconds per minute**

= **50 working minutes per hour** × **60 seconds per minute**

= **3,000 seconds per hour**

Step 3. Determine the production rate.

Production rate (LCY per hour)

= $\frac{\mathbf{B} \times \mathbf{T} \text{ (seconds per hour)}}{\mathbf{CT} \text{ (seconds)}}$

= $\frac{\mathbf{0.75 \text{ cubic yard} \times \mathbf{3,000 \text{ seconds per hour}}}{\mathbf{40\text{-second cycle}}}$

= **56 LCY per hour**

where—

B = bucket size

T = working time

CT = cycle time

Step 4. Determine the soil conversion factor, if needed.

Soil conversion factor = not applicable

Step 5. Determine the total time required to complete the job.

$$\text{Total time (hours)} = \frac{\text{quantity of material moved (LCY)}}{\text{production rate (LCY per hour)}} = \frac{450 \text{ LCY}}{56 \text{ LCY per hour}} = 8 \text{ hours}$$

OPERATION TIPS

- Position the unit on level ground.
- Position the unit so digging operations are at the same radius as the dumping operation. This will avoid wasted production caused by raising and lowering the boom.
- Select the correct bucket size for the machine. Efficient use of the clamshell means an efficient digging, hoisting, swinging, and dumping cycle. Large buckets may increase the cycle time.
- Remove the bucket teeth when working in soft materials.

DRAGLINE

7-39. Dragline components consist of a drag bucket and a fairlead assembly. Wire ropes are used for the drag, the bucket hoist, and the dump lines. The fairlead guides the drag cable onto the drum when the bucket is being loaded. The hoist line, which operates over the boom-point sheave, raises and lowers the bucket. In the digging operation, the drag cable pulls the bucket through the material. When the bucket is raised and moved to the dump point, it is emptied by releasing the tension on the drag cable. Dragline buckets are rated by type and class, as follows:

- **Bucket types.** Type I (light duty), Type II (medium duty), and Type III (heavy duty). The Army usually uses Type II buckets.
- **Bucket classes.** Class P (perforated plate) and Class S (solid plate). The Army usually uses Class S buckets.

USE

7-40. The dragline (see *Figure 7-2, page 7-2*) is a versatile attachment capable of a wide range of operations at or below ground level. It can handle material ranging from soft to medium-hard. The greatest advantage of a dragline over other machines is its long reach for digging and dumping. A dragline does not have the positive digging force of a shovel or backhoe. Breakout force is derived strictly from bucket weight. The bucket can bounce, tip over, or drift sideward when it encounters hard material. These weaknesses are particularly noticeable with lightweight buckets.

7-41. Use a dragline for trenching, stripping overburden, cleaning and digging roadside ditches, and sloping embankments. The dragline is the most practical attachment to use when handling mud. The dragline's reach allows it to excavate an extensive area from one position. The sliding action of the bucket decreases suction problems.

NOTE: Do not use the dragline attachment with hydraulic cranes.

CAPACITY

7-42. The dragline boom may be angled relatively low when operating. Boom angles of less than 35° from the horizontal plane are seldom advisable because of the possibility of tipping the machine. When excavating wet, sticky material and casting it onto a spoil bank, the chance of tipping increases because of material sticking in the bucket.

Casting Material

7-43. The throw or cast of the bucket increases the dragline's operating radius, which can be up to one-half of the boom height (*Figure 7-9, page 7-16*).

WARNING

Only experienced operators should perform extended casting because of the possible damage to the cables or the boom or the possibility of tipping the machine.

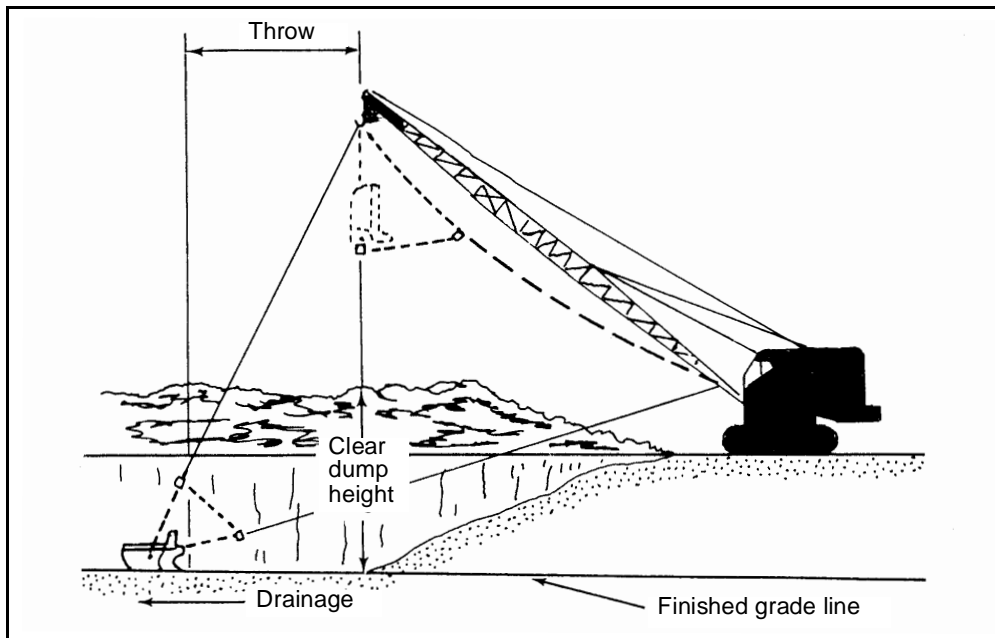


Figure 7-9. Dragline Throw

Excavating a Trench

7-44. The dragline carriage should be in line with the trench centerline. This is called the *in-line approach* (Figure 7-10). The dragline excavates to the front while moving backwards and dumping on either side of the excavation. To ensure drainage during construction, always start at the lower end of the trench.

Sloping an Embankment

7-45. An effective use of a dragline is to dress the face of an embankment by working from the bottom to the top. Position the machine on the top of the embankment with the tracks parallel to the working face. This is called the *parallel approach* (Figure 7-11). This positioning enables the machine to move the full length of the job without excessive turning.

Digging Underwater (Dredging) or in Wet Materials

7-46. A dragline is ideal for removing materials from areas such as water-filled trenches, canals, gravel pits, or ditches. Digging underwater or in wet materials increases the material's weight and frequently prevents the hoisting of heaped bucket loads. Plan operations so that the material being handled is as dry as possible. Always provide good project drainage. Drainage projects involving ditch excavation through swamps or soft terrain are common. Under these conditions, cast the excavated material onto a levee or spoil bank, which eliminates the problem of constructing roads for hauling-type equipment. It may be necessary to construct rudimentary service roads to support the construction effort and to get fuel to the machine.

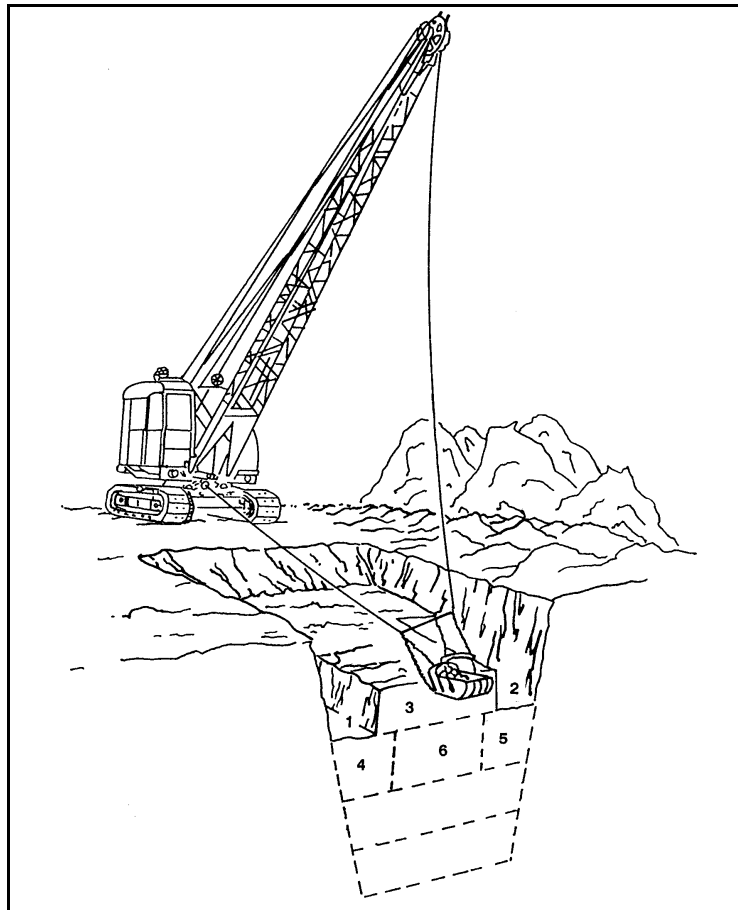


Figure 7-10. In-Line Approach With a Dragline

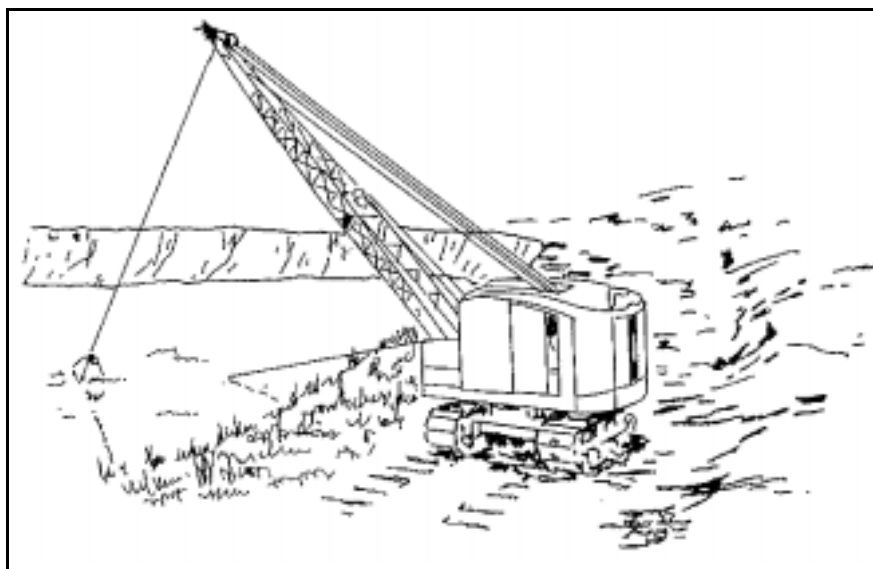


Figure 7-11. Parallel Approach With a Dragline

Loading Haul Units

7-47. Where job conditions require loading excavated material into hauling units, plan the excavation so that the loaded trucks can travel on dry ground and over minimum grades when exiting the loading area. Spot trucks for minimum boom swing. If possible, spot the truck bed under the boom tip with the truck's long axis parallel to the long axis of the boom. However, it is more common to have to spot the truck at a right angle to the boom. Spotting the haul units in the excavation below the dragline will reduce hoist time and increase production. The dragline, not being a rigid attachment, will not dump its material as accurately as other excavators. Therefore, the operator will need more time to spot the drag bucket before dumping.

PRODUCTION ESTIMATES

7-48. Table 7-2 gives the hourly production rates for cranes with a dragline attachment. These rates are based on the optimum cutting depth, a 90° swing angle, the soil type, and the maximum efficiency. Table 7-3 gives correction factors for different depths of cut and swing angles. Refer to Table 1-1, page 1-4, for soil conversion factors. Determine overall efficiency from past experiences.

Table 7-2. Dragline Hourly Output in BCY

Material	Dragline Bucket Size (Cubic Yards)								
	3/8	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/2
Clay or loam (light and moist)	5.0 70.0	5.5 95.0	6.0 130.0	6.6 160.0	7.0 195.0	7.4 220.0	7.7 245.0	8.0 265.0	8.5 305.0
Sand or gravel	5.0 65.0	5.5 90.0	6.0 125.0	6.6 155.0	7.0 185.0	7.4 210.0	7.7 235.0	8.0 255.0	8.5 295.0
Good common earth (soil)	6.0 55.0	6.7 75.0	7.4 105.0	8.0 135.0	8.5 165.0	9.0 190.0	9.5 210.0	9.9 230.0	10.5 265.0
Clay (hard and tough)	7.3 35.0	8.0 55.0	8.7 90.0	9.3 110.0	10.0 135.0	10.7 160.0	11.3 180.0	11.8 195.0	12.3 230.0
Clay (wet and sticky)	7.3 20.0	8.0 30.0	8.7 55.0	9.3 75.0	10.0 95.0	10.7 110.0	11.3 130.0	11.8 145.0	12.3 175.0

NOTE: The top figures give the optimum depth of cut (in feet). The bottom figures give the estimated BCY per hour.

Table 7-3. Depth-of-Cut and Swing-Angle Correction Factors for Dragline Output

Depth of Cut (in Percent of Optimum)	Swing Angle (Degrees)							
	30	45	60	75	90	120	150	180
20	1.06	0.99	0.94	0.90	0.870	0.81	0.75	0.70
40	1.17	1.08	1.02	0.97	0.930	0.85	0.78	0.72
60	1.24	1.13	1.06	1.01	0.970	0.88	0.80	0.74
80	1.29	1.17	1.09	1.04	0.990	0.90	0.82	0.76
100	1.32	1.19	1.11	1.05	1.000	0.91	0.83	0.77
120	1.29	1.17	1.09	1.03	0.985	0.90	0.82	0.76
140	1.25	1.14	1.06	1.00	0.960	0.88	0.81	0.75
160	1.20	1.10	1.02	0.97	0.930	0.85	0.79	0.73
180	1.15	1.05	0.98	0.94	0.900	0.82	0.76	0.71
200	1.10	1.00	0.94	0.90	0.870	0.79	0.73	0.69

EXAMPLE

Determine the hourly output for a 3/4-cubic-yard crawler dragline.

Bucket size = 3/4 cubic yard

Material = good common earth

Angle of swing = 45°

Depth of cut = 9 feet

Step 1. Determine the ideal production from *Table 7-2*.

Ideal production = 105 BCY per hour at an optimum depth of cut of 7.4 feet

Step 2. Determine the ratio of the actual depth of cut to the optimum depth of cut, expressed as a percent.

Cut ratio (percent)

$$= \frac{\text{actual depth of cut}}{\text{optimum depth of cut}} \times 100$$

$$= \frac{9 \text{ feet}}{7.4 \text{ feet}} \times 100$$

$$= 122 \text{ percent of optimum}$$

Step 3. Determine the depth-of-cut/swing-angle correction factor from *Table 7-3*. In some cases it may be necessary to interpolate between *Table 7-3* values.

Correction factor = 1.17

Step 4. Determine an overall efficiency factor based on the job conditions. Draglines seldom work at better than a 45-minute working hour.

$$\text{Efficiency factor} = \frac{45 \text{ minutes}}{60 \text{ minutes}} = 0.75$$

Step 5. Determine the production rate. Multiply the ideal production by the depth-of-cut/swing-angle correction factor and the efficiency factor.

$$\text{Production rate} = 105 \text{ BCY per hour} \times 1.17 \times 0.75 = 92.1 \text{ BCY per hour}$$

Step 6. Determine the soil conversion factor, if needed.

Soil conversion factor = not applicable

OPERATION TIPS

- Position the machine to eliminate unnecessary casting and hoisting, although the dragline bucket can easily be cast beyond the length of the boom.
- Use heavy timber mats for work on soft ground. Keep the mats as level and clean as possible.

WARNING

Do not guide the dragline bucket by swinging the superstructure while digging. This puts side stress on the boom, which can cause the boom to collapse. Raise the bucket clear of the ground before swinging the boom.

SAFETY

OPERATOR RESPONSIBILITIES

7-49. Thoroughly train operators in crane safety before allowing them to operate a crane. Operators are responsible for knowing the limitations and capabilities of cranes and how to read a load chart properly. Operators must not operate an unsafe crane. They must be able to identify and promptly report any equipment malfunction or defect. Operators have the authority to stop and refuse to handle loads until safety has been assured.

HAND SIGNALS

7-50. Use a signal person whenever the point of operation is not in full and direct view of the equipment operator. When using hand signals, designate only one person to give the signals to the operator. The signal person must be totally dependable and fully qualified. The signal person must use a uniform system of signals and must be clearly visible to the operator at all times. *Figure 7-12* shows the hand-signal system recommended for directing crane-shovel operations. Check the operator's manual for other equipment signals. Ensure that operators and signalmen have a full understanding of the meaning of all signals. See *Chapter 13* for additional crane-safety precautions.

ACCIDENT PREVENTION

7-51. Common hazards associated with operating hook blocks, clamshells, pile drivers, and draglines are—

- The boom contacting high-voltage electric wires. This is the most hazardous aspect of crane operation.
- The cables breaking.
- The clutch or brake slipping, allowing the boom radius to increase.
- Obstruction of the free passage of the boom or the load.
- Operation on uneven ground.
- Not knowing the actual weight of the load being hoisted.
- Bent or dented chord members on the boom.

7-52. Common operator errors associated with crane operations are—

- Dropping or slipping the load.
- Not using outriggers.
- Not using mousing or safety-type hooks.
- Not being familiar with the equipment.
- Not referring to load charts when using different boom lengths.
- Using the crane hoist cable for towing. The boom is designed for handling vertical loads only.

7-53. Personnel should never attempt to climb on or off of a crane when it is operating. No personnel except the operators and, on occasion, examiners, supervisors, trainees, or repairers, should be on a crane while it is in operation.

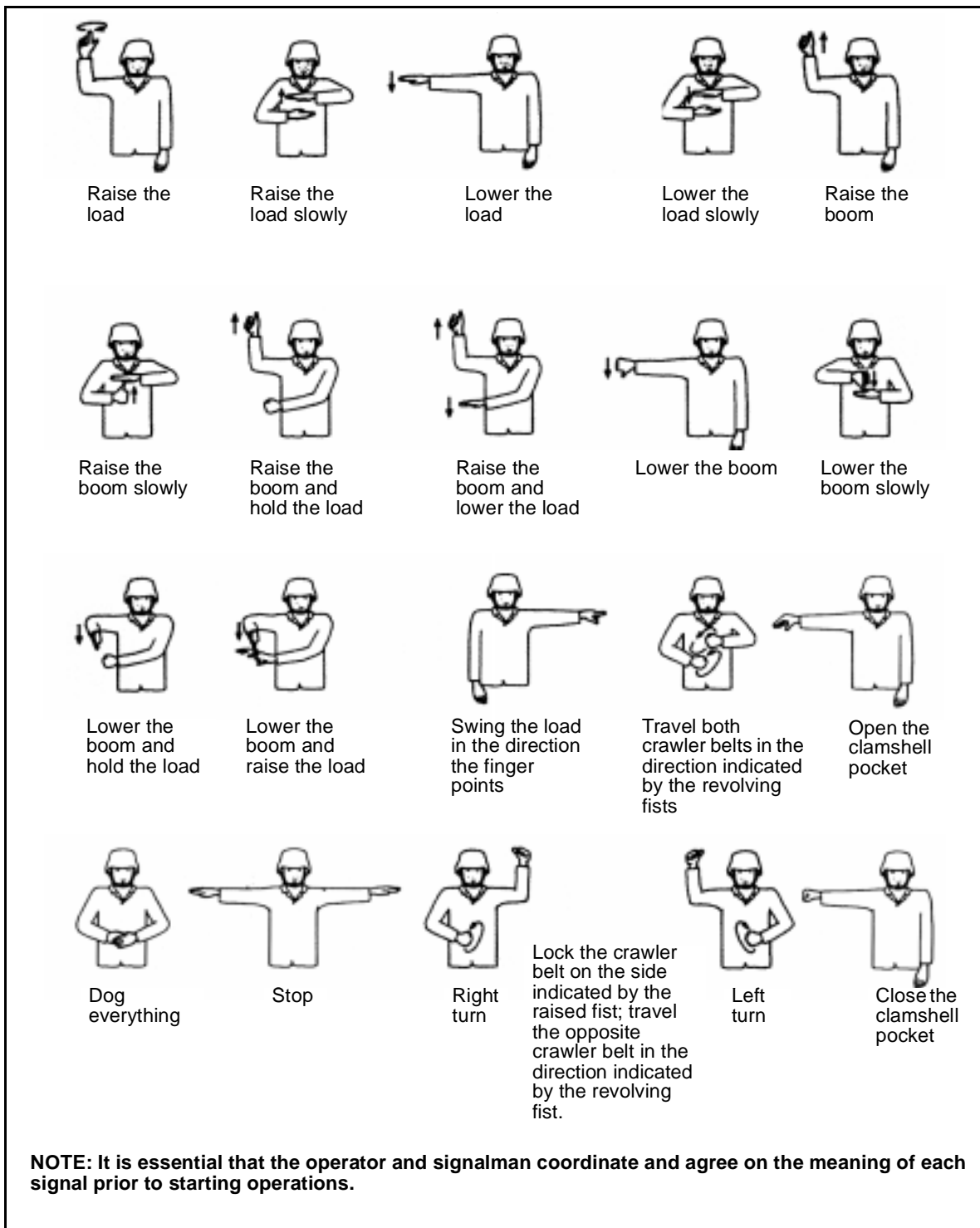


Figure 7-12. Hand Signals for Crane-Shovel Operations

7-54. When hoisting a load from below water, the crane takes on the added load imposed by the displaced water as the load is hoisted out of the water. Never hoist unknown weights from the water. Consider the water contained in the load or in a waterlogged structure as part of the load's weight. Never handle waterlogged loads or loads from water or mud without first determining whether the weight of the load and the water are within the crane's hoisting capacity.

7-55. When handling a heavy load, raise it a few inches to determine whether there is undue stress on any part of the sling and to ensure that the load is balanced. If anything is wrong, lower the load at once and do not attempt to move it until the necessary adjustment or repair has been made.

7-56. Before hoisting a near-capacity load, make sure the hoisting line is vertical. Move the crane instead of lowering the boom, since swinging a capacity load increases the chance of tipping.

7-57. When lowering a boom under load, use extreme caution. Check the load chart with attention to radius changes and observe the radius indicator. These charts are posted in the operator's cab. Never lower the hoisting line and the boom simultaneously.

7-58. When lowering loads, use a low speed not to exceed the hoisting speed of the equipment for the same load. The ordinary hoisting speed of a 30-ton, motor-operated crane is about 18 feet per minute with a rated load. Stopping the load at such speeds in a short distance may double the stress on the slings and crane.

7-59. Be careful to guard workers, buildings, or scaffolds against injury from swinging loads. Do not swing loads over workers. If it is necessary to move loads over occupied areas, give adequate warning (by bell or siren) so workers can move into safe locations.

7-60. Do not attempt dual lifts unless absolutely necessary and only with competent supervision throughout the operation. Dual lifts are extremely dangerous. Shifting of the load can cause overloading and failure of one crane. This throws the entire load onto the second crane causing it to fail. Before making a dual lift, carefully determine the position for the cranes and the location of the slings to balance the load properly.

7-61. After repair or alteration of a crane or derrick involving its hoisting capacity or stability, have a competent person determine its safe working load. Have this person issue a written statement specifying the safe working load.

7-62. Test the brakes at the beginning of each new shift, after a rainstorm, or at any other time when brake linings may have become wet. When hoisting a capacity load, check the brakes by stopping the hoist a few inches above the ground and holding it with the brake.

7-63. Equip all cranes with appropriate fire extinguishers. Keep the extinguishers maintained and ready for use.

7-64. Never attempt to pull pipes or other objects out of the ground.

PILE-DRIVER SAFETY

7-65. When positioning a crane to drive piles, prepare a level work platform and use outriggers to maintain crane stability. When in operation, use safety lashings for all hose connections to pile drivers, pile ejectors, or jet pipes. Use tag lines to control piles and hammers. When hoisting steel piling, use a closed shackle or other positive means of attachment. Only the pile-driving crew members should be permitted in the work areas when driving piles. Pile-driver operators should be aware of the following safety precautions:

- **Repairs.** Never repair any diesel or air equipment while it is in operation or under pressure.
- **Air hoses.** Make frequent inspections of air hoses to locate defects and promptly replace any defective air hoses.
- **Power lines.** Make sure that machines or equipment do not come too close to electric power lines. The machine does not actually have to contact a power line for the machine to be energized.
- **Hammer and driving heads.** When a pile driver is not in use, use a cleat or timber to hold the hammer in place at the bottom of the leads. Secure the driving heads when using the rig to shift cribbing or other material. Never place your head or other parts of your body under suspended hammers that are not dogged or blocked in the leads.
- **Drums, brakes, and leads.** Keep hoisting drums and brakes in the best condition possible and shelter them from the weather. Keep leads well greased to provide smooth hammer travel.

