ENGINEERING-PDH.com
ONLINE CONTINUING EDUCATION

DOZER & ROLLERS BASICS & SAFETY

Main Category:	Civil Engineering
Sub Category:	-
Course #:	CIV-119
Course Content:	37 pgs
PDH/CE Hours:	3

COURSE/EXAM PREVIEW

(HIT BACK TO RETURN TO ENGINEERING-PDH.COM)

WWW.ENGINEERING-PDH.COM
TOLL FREE (US & CA): 1-833-ENGR-PDH (1-833-364-7734)
SUPPORT@ENGINEERING-PDH.COM

CIV-119 EXAM PREVIEW

Instructions:

- Review the course & exam preview below.
- Click "Add to Cart" from the course page on the website. You can "Continue Shopping" to add additional courses, or checkout. Don't forget to apply your coupon code if you have one before checkout.
- After checkout you will be provided with links to download the official courses/exams.
- At your convenience and own pace, you can review the course material. When ready, select "Take Exam" to complete the live graded exam. Don't worry, you can take an exam as many times as needed to pass.
- Upon a satisfactory completion of the course exam, which is a score of 70% or better, you will be provided with your course completion certificate. Be sure to download and print your certificates to keep for your records.

Exam Preview:

1. Backfilling is the process of replacing excavated earth. When a culvert is backfilled, the dozer should not cross the culvert unless there is at least 12 inches of compacted material on top of the culvert.
   a. True
   b. False
2. The track frame serves as a framework and support for the track assembly, rollers, front idler, recoil spring, and adjusting mechanism. Which of the following components matches the description: serves as a guiding support for the track chain?
   a. Rollers
   b. Front idler
   c. Recoil spring
   d. Adjusting mechanism
3. The angle blade is a multipurpose tool that can be used for general dozing and for the side casting of materials. The angle blade can be positioned straight ahead or angled __ degrees to either side.
   a. 55
   b. 45
   c. 35
   d. 25
4. According to the reference material, to clear brush and small trees with a dozer, travel forward at a high speed with the blade lowered several inches below grade.
   a. True
   b. False

5. A winch is mounted on the rear of the dozer and is directly geared to the rear power takeoff. This arrangement permits development of a line pull that is 50 to __ percent greater than straight dozer pull.
    a. 75
    b. 100
    c. 125
    d. 150
6. The sheepsfoot drum is used for compacting heavy lifts of 6 to 12 inches thick. As consecutive passes are made, the drum will start to walk out of the ground as the penetration of the sheepsfoots decrease.
    a. True
    b. False
7. According to the reference material, side-by-side dozing requires time-consuming maneuvering of the dozers; therefore, it is impractical for hauls of less than 50 feet and more than ___ feet.
    a. 150
    b. 200
    c. 250
    d. 300
8. When you are rolling bituminous materials, the rollers should move at a slow, uniform speed with the drive wheels positioned toward the paver. The speed should not exceed 3 mph for steel-wheeled rollers or _ mph for pneumatic-tired rollers.
    a. 10
    b. 5
    c. 8
    d. 12
9. The vibration frequency of rollers used for com-paction is generally between 2,000 to 3,000 vibrations per minute (vpm), depending on the model and manufacturer.
    a. True
    b. False
10. A dozer blade cutting edge and corner bits are bolted to the bottom of the blade. Which of the following blade configuration matches the description: drifts large volume loads efficiently over long distances?
    a. Straight Blade
    b. Box Blade
    c. Angle Blade
    d. “U” Blade

DOZERS AND ROLLERS

BASICS & SAFETY

The dozer, technically known as a **crawler tractor,** is used as follows: as a prime mover for pushing or pulling loads, as a power unit for winch operations, or as a dozer for earthwork operations and demolition work. Rollers are compaction equipment used to achieve mechanical compaction of earthwork materials required by project specifications.

A variety of makes and models of dozers and rollers are used by the Navy and the Naval Construction Force (NCF). Each operator is responsible for reading the operator's manual to obtain detailed information about each make and model. This chapter covers the general characteristics and basic principles of dozer and roller operations.

DOZERS

The dozer, commonly called a **bulldozer,** is a crawler tractor on which a dozer blade has been mounted (fig. 11- 1). Dozers are usually rated by size and power. The pull developed at the drawbar is expressed in pounds or as **drawbar horsepower.** The drawbar pull is greatest in the lowest transmission gear range. Although the specifications for dozers may vary among different manufacturers, the maximum speeds are seldom in excess of 8 mph.

The dozer is equipped with a diesel engine and is supported on the ground by a track assembly. The track assembly provides all-type-terrain versatility due to the low ground bearing pressure at the track. This lower ground bearing pressure, varying from 6 to 9 pounds per square inch, has a distinct **flotation** advantage over rubber-tired equipment ground bearing pressure that varies from 25 to 35 pounds per square inch. Dozers are capable of operating efficient y in muck or water as deep as the height of the track for short periods of time. When the dozer is properly waterproofed, it can operate in fairly deep water.

CAUTION

When working in water that is deep enough to reach the radiator, be sure to disconnect the fan belt. If the fan blades hit the water while under power, the y could bend or break off, possibly causing damage to the radiator. Additionally, exercise extreme caution to ensure the engine does not overheat when the fan or water pump belts are disconnected.

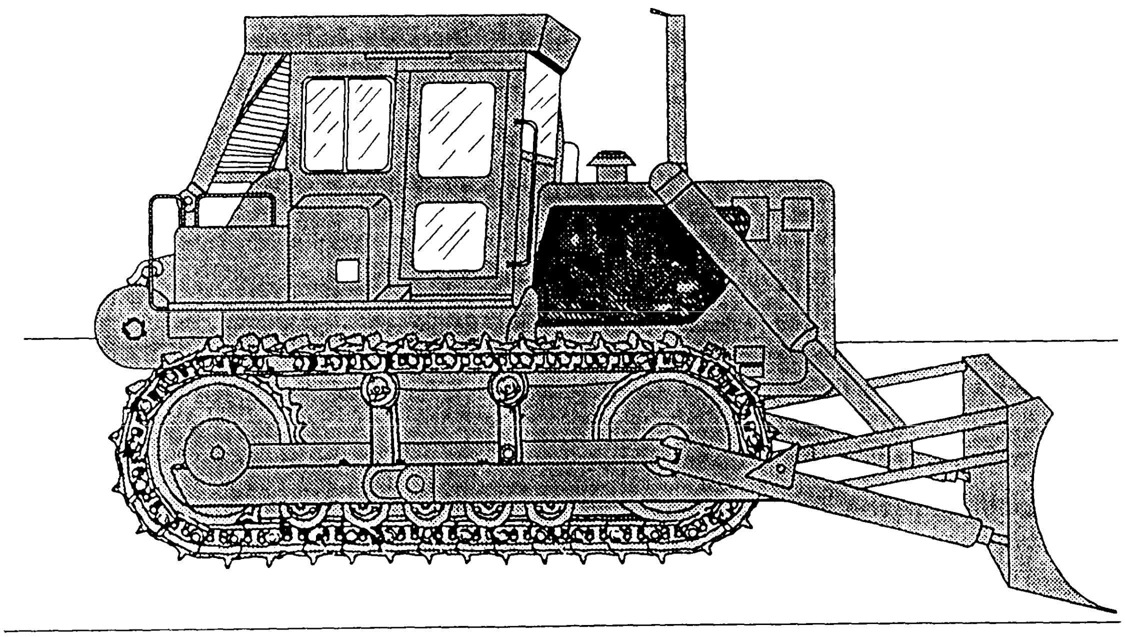


Figure 11-1.—Dozer.

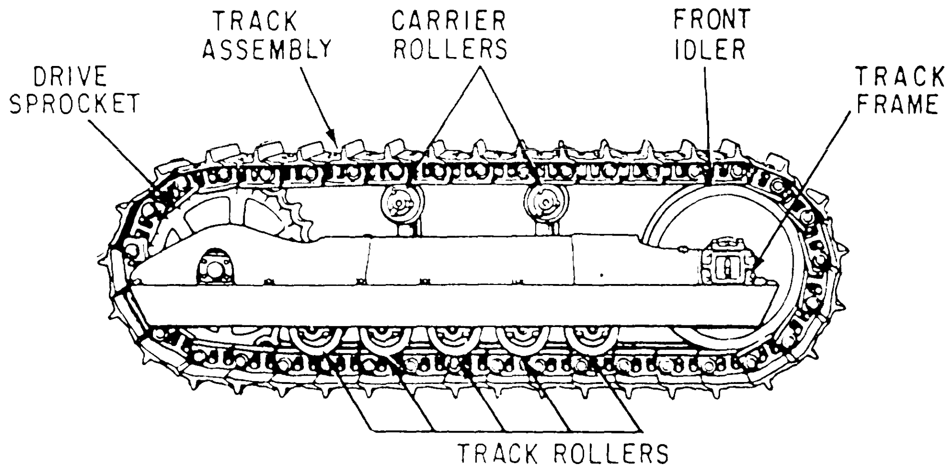


Figure 1-2.-Side view of crawler tractor chassis.

Dozers can move from jobsite to jobsite under their own power at slow speeds; however, this is a poor practice and tends to shorten the operational life of the dozer. For this reason, dozers should be transported by tractor-trailer from jobsite to jobsite.

TRACKS AND TRACK FRAME

The undercarriage of the crtiwlcr-mounted dozer contains two major components: **track assembly and track frame.** The undercarriage (fig. 11-2) shows positive traction, allowing efficient operations.

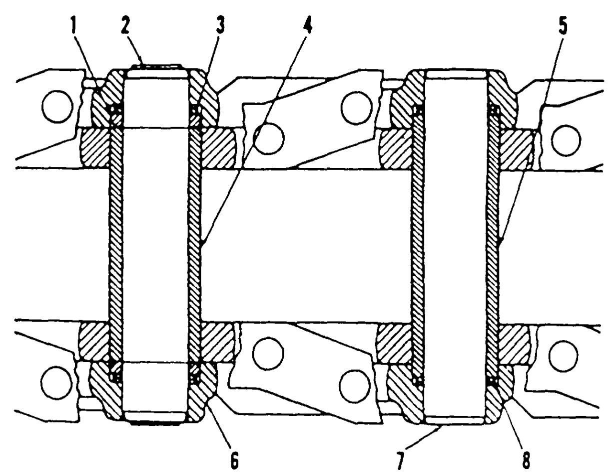
Track Assembly

The track assembly consists of a continuous chain surrounding the track frame and drive sprocket. The links of the chain provide a flat surface for the track rollers to pass over, as they support the equipment. Track shoes are bolted to the outside of the chain links and distribute the weight of the equipment over a large surface. The distribution of the weight is the ground bearing pressure.

TRACK CHAIN.— Figure 11-3 shows a cutaway view of a section of track chain, showing the internal arrangement of the pins and bushings. As the dozer operates, the drive sprocket teeth contact the track pin bushings and propel the dozer along the track assembly.

The pins and bushings wear much faster than other parts of the track because of their constant pivoting, as the track rotates around the track frame. The pivoting results in internal wear of both pins and bushings. As the pins and bushings wear, the track lengthens. When it does, the track should be adjusted to remove any slack.

Extensive wear on the outside of bushings is a good indication of inner wear. Manufacturers have set specifications for the maximum wear allowed before a track has to be rebuilt. To determine if a track should be removed for rebuilding or replacement, measure the outside of the bushings and track pitch (length of the track). Measure the outside of the bushing at the location at which it shows the most wear using a caliper and ruler, as shown in figure 11-4. Compare this measurement with the manufacturers' specifications. Measure the



1. Spacer
2. Master Pin
3. Coned-Disk Seal Washers
4. Master Bushing
5. Track Bushing
6. Link
7. Track Pin
8. Coned-Disk Seal Washer

Figure 11-3.—Track chain.

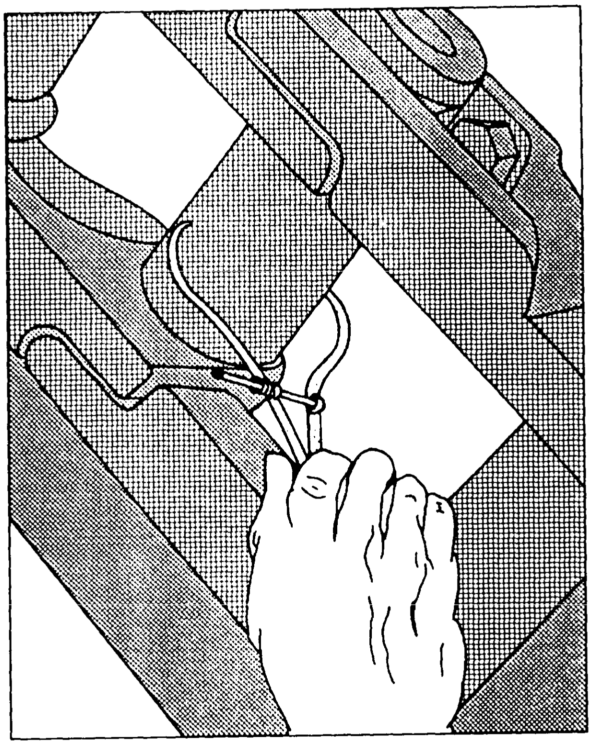


Figure 11-4.—Bushing wear measurement.

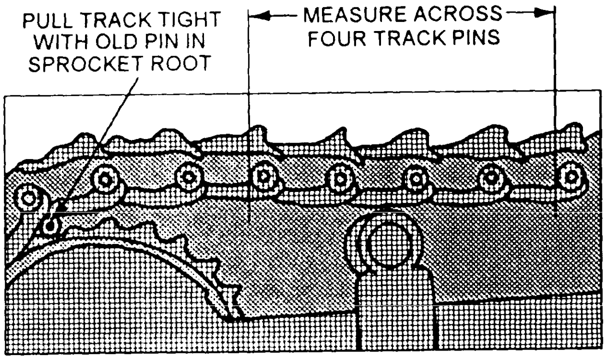


Figure 11-5.—Track pitch measurement.

track pitch with a ruler or tape measure after tightening the track to remove any slack, as shown in figure 11-5.

TRACK SHOES.— The most common track shoe is the grouser shoe, as shown in figure 11-6. This shoe is standard on crawler-mounted dozers. The extreme service track shoe shown in figure 11-7 is equipped on crawler-mounted dozers that operate primarily in rocky locations, such as rock quarries and coral beaches. Notice the grouser, or raised portion of the shoe, is heavier than the one on the standard grouser shoe.

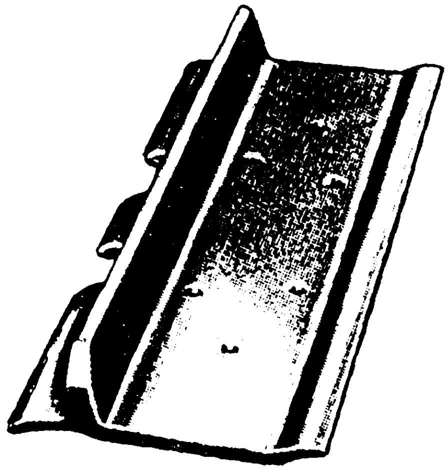


Figure 11-6.-Standard grouser shoe.

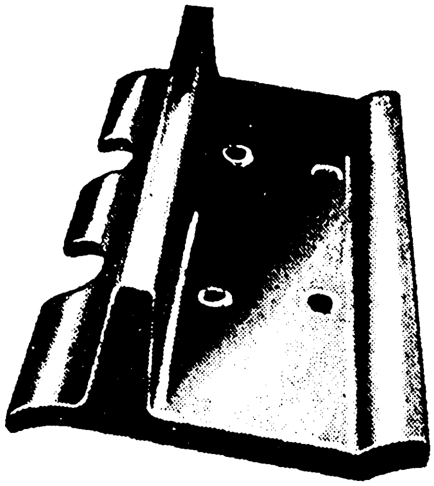


Figure 11-7.—Extreme service track shoe.

NOTE: The grouser absorbs most of the wear and its condition can indicate when a track needs replacement or overhaul.

Track Frame

The track frame serves as a framework and support for the track assembly, rollers, front idler, recoil spring, and adjusting mechanism.

TRACK FRAME ROLLERS.— Two types of track frame rollers are used on tracked equipment: those located on the lower portion of the track frame, which support the weight of the dozer, and those mounted above the track frame, which support the track, as it passes over the track frame assembly.

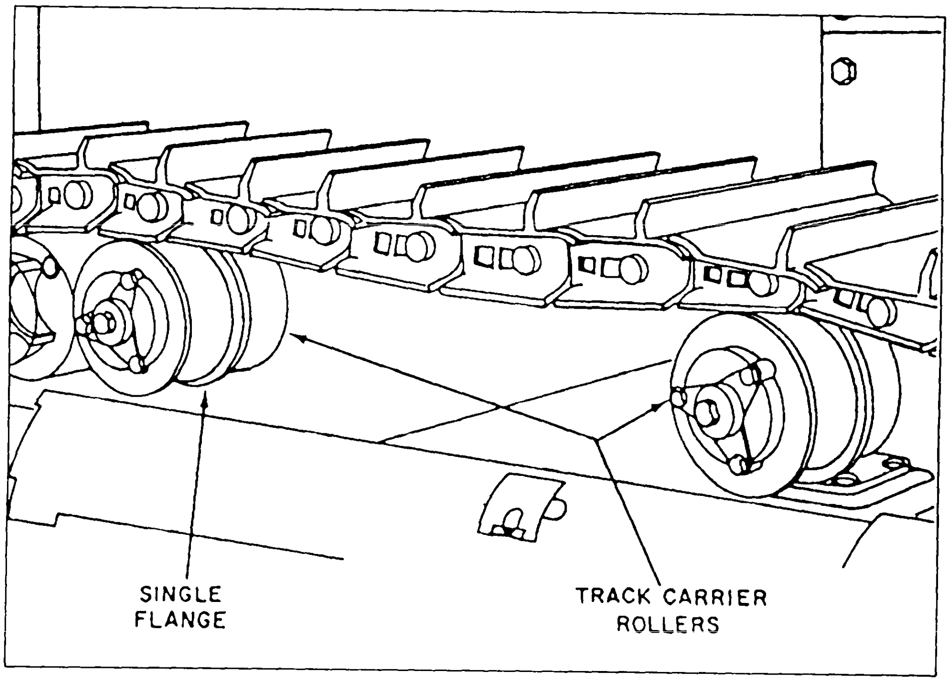


Figure 11-8.-Carrier rollers.

The carrier rollers are mounted on brackets that extend above the track frame (fig. 11-8). Two of these rollers are on each side of the dozer. The single flange on the rollers extends upward between the links of the track chain and keeps the chain in alignment between the drive sprocket and the front idler.

The track rollers support the weight of the dozer and ensure the track chain is in alignment with the truck frame, as it passes under the rollers (fig. 11-9). Track rollers, both single and double flanged, are installed alternately. In the normal arrangement, a double-flanged roller is positioned directly in front of the rear drive sprocket, followed by a single-flanged roller. The rollers alternate forward to the front idler.

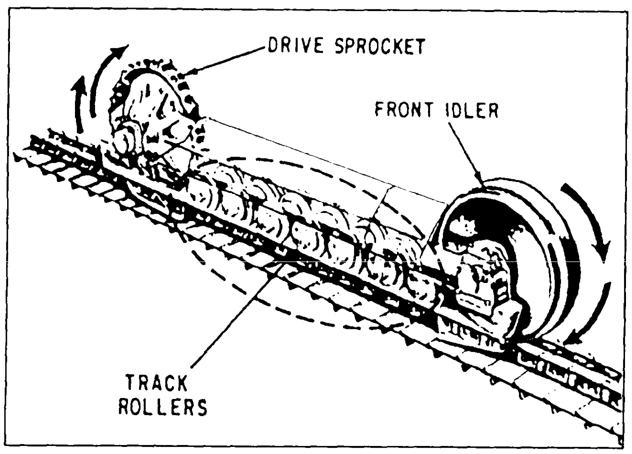


Figure 11-9.—Track rollers in position in track frame.

FRONT IDLER.— The front idler, as shown in figure 11-9, serves as a guiding support for the track chain. The idler is spring-loaded and mounted on slides, or guides, that allow it to move back and forth inside the track frame, as the dozer passes over uneven ground. The spring-loading effect causes the idler to maintain the desired tension regardless of operating conditions.

RECOIL SPRING.— The recoil spring is a large coil spring placed in the track frame in a way that enables the spring to absorb shock from the front idler. The spring is compressed before installation and held in place by stops or spacers. The track adjusting mechanism, by pressing against the spring stop, maintains the desired tension on the track assembly by holding the idler and yoke in the forward position. The operation of the coil spring depends on the amount of tension on the truck.

TRACK ADJUSTING MECHANISM.— The adjusting mechanism must be extended enough to remove slack between the front idler and spring. The adjustment is made either manually (fig. 11-10) or hydraulically (fig. 11-11). Older model dozers have mnaually adjustments; whereas, newer dozers are

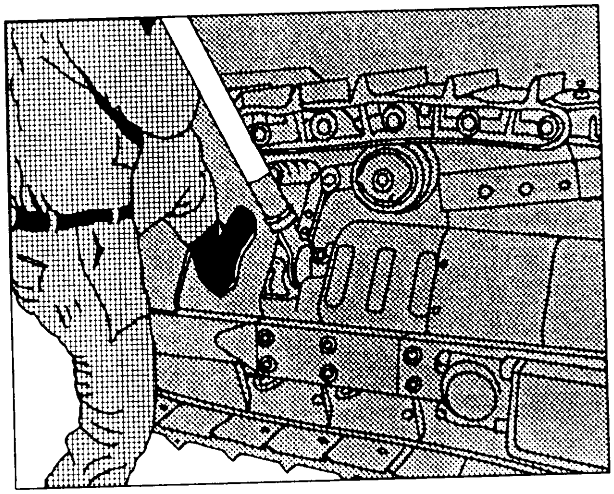


Figure 11-10.-Manual track adjustment.

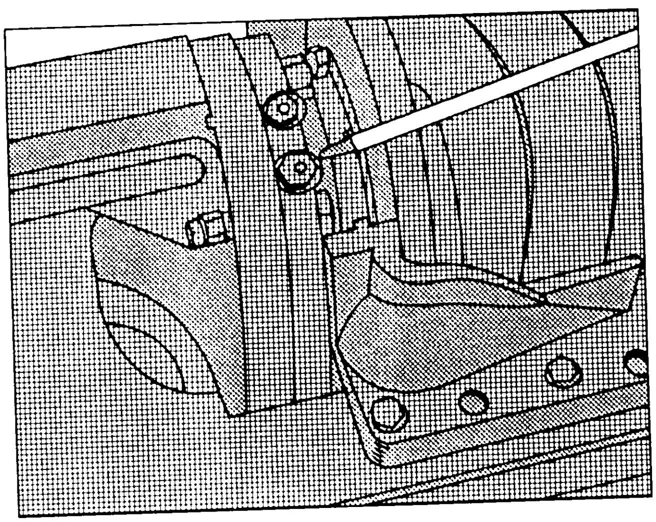


Figure 11-11.-Hydraulic track adjuster.

adjusted hydraulically with a grease gun. Grease is pumped into the yoke cylinder and extends it until enough tension is placed on the recoil spring to remove the slack from the track. Tension is relieved by loosening the vent screw located next to the adjustment fitting.

NOTE: Do NOT lubricate this fitting when performing daily operator's maintenance. The track adjuster fitting should only be greased when the tracks require adjustment.

Track Adjustment.— To determine proper track tension, position the dozer on a hard surface. Then place a straightedge over the front carrier roller and idler with all slack removed from the rest of the track. The tension is correct when the measured distance is as shown in figure 11-12.

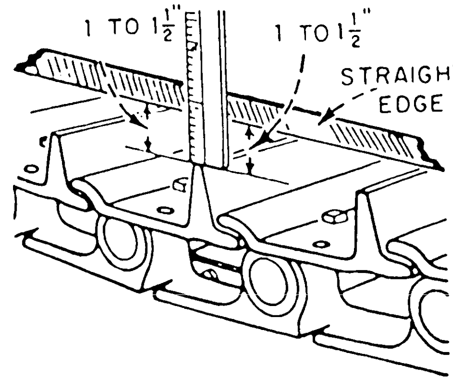


Figure 11-12.—Checking track adjustment.

Track tension should be suitable for the type of area you arc working in, such as tighter for rock and looser for sand and snow. However, if the tracks are adjusted too tightly, there will be too much friction between the pins and bushings when the track links swivel, as they travel around the sprocket and front idler. This friction causes the pins, bushings, links, sprocket, and idler to wear rapidly. Friction in a tight track also robs the tractor of needed horsepower.

Tracks that are too loose fail to stay aligned and tend to come off when the tractor is turned. As a result, the idler flanges, roller flanges, and the sides of the sprocket teeth wear down. A loose track will whip at high speeds, damaging the carrier rollers and their supports. If loose enough, the drive sprockets will jump teeth (slide over the track bushings) when the tractor moves in reverse. Should this happen, the sprocket and bushings will wear rapidly.

NOTE: Checking and performing track adjustments arc the opcrator's responsibility.

Lubrication.— The track pins and bushings are hardened and require no lubrication. Many roller idlers arc equipped with lifetime seals that are filled during assembly and require no lubrication. However, track rollers, carrier rollers, and idlers equiped with grease fittings must be lubricated on a schedule based on the manufacturer's specifications.

NOTE: Fittings should be cleaned before lubricating to prevent forcing dirt and grime into the bearings.

ATTACHMENTS

The most common type of dozer attachment is the dozer blade, a heavy, rectangular steel blade, that is on

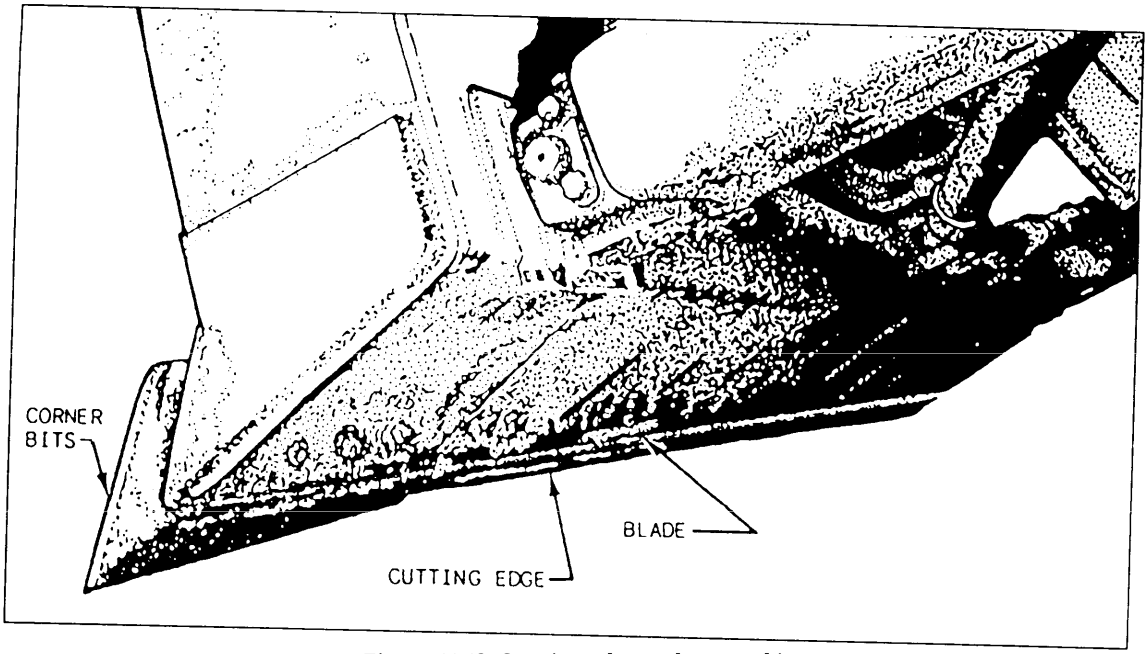


Figure 11-13.-Cuttting edge and corner bit.

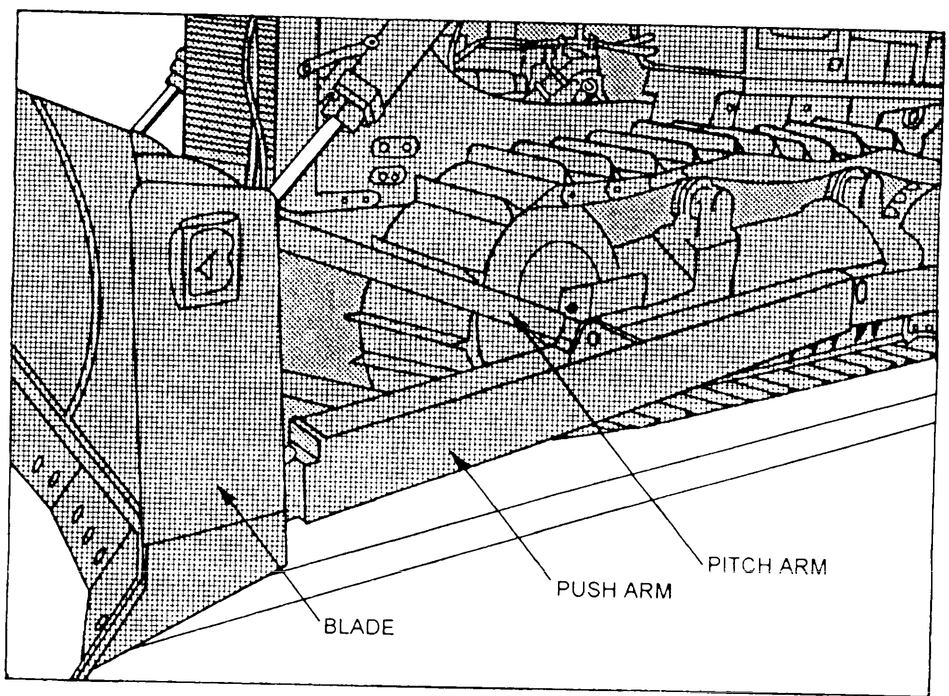


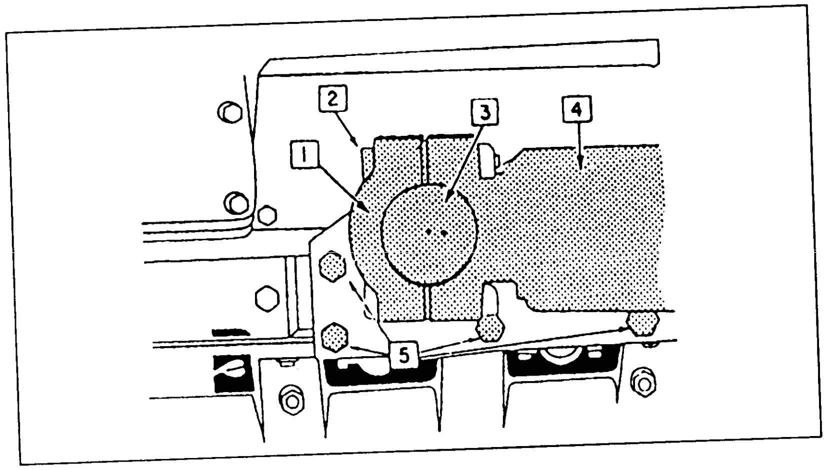
Figure 11-14.—Dozer blade, push and pitch arms.

the front of the crawler tractor. It is used for drifting (pushing straight ahead) or side casting (pushing to one side) materials. Other attachments include rippers and winches.

Dozer Blades

A dozer blade cutting edge and corner bits are boltcd to the bottom of the blade (fig. 11-13). Remember, checking the cutting edges for wear is the operator's responsibility. The blade is connected to two push arms and two pitch arms, as shown in figure 11-14.

Most push arms are attached to the bottom of the blade and to the outside of the track frame at the trunnion (fig. 11-15). On dozers equipped with an angle blade, the-push arms are a "C" frame confjguration. The "C" frame is attached to the trunnions and wraps around the front of the dozer. The blade is attached to the "C" frame with a steel pin.



1. CAP, trunnion
2. BOLT, cap
3. TRUNNION
4. "C" FRAME or PUSH ARM
5. CAP SCREW, trunnion mounting

Figure 11-15.—Push arm and trunnion.

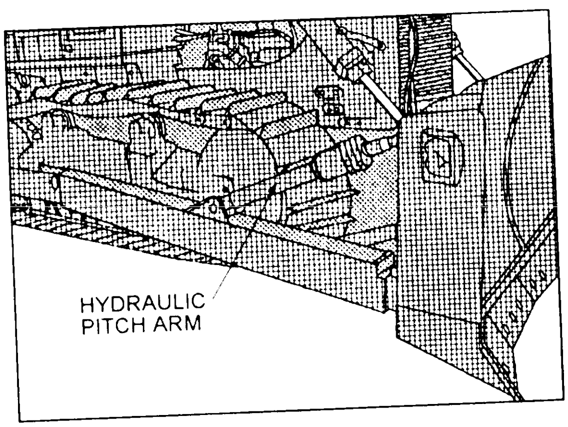


Figure 11-16.—Hydraulic pitch arm.

Pitch arms arc diagonal members between the push arm and the top of the blade. They brace the blade against loads above the push arms and provide a means of regulating the blade pitch and tilt. The pitch arms may be threaded or have a hydraulic cylinder, as shown in figure 11-16. To pitch the blade forward, lengthen the arms. The forward blade pitch is for dozing extremely hard materials. Pitch the blade back by shortening the pitch arms. The back blade pitched is good for leveling, spreading, or cleaning of loose material without the blade digging in. Tilting is done by shortening one arm and lengthening the other.

STRAIGHT BLADE.— The straight blade (fig. 11- 17) is ideal for general dozing when materials are to

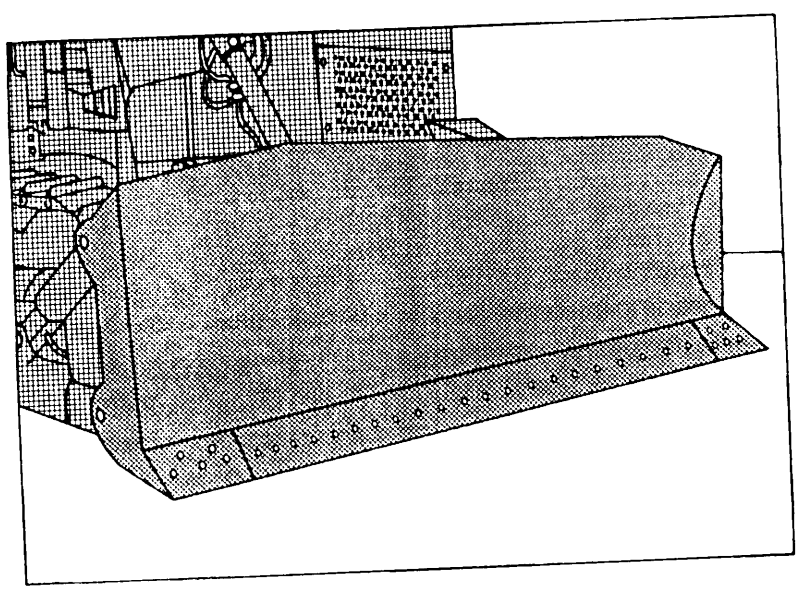


Figure 11-17.-Straight blade.

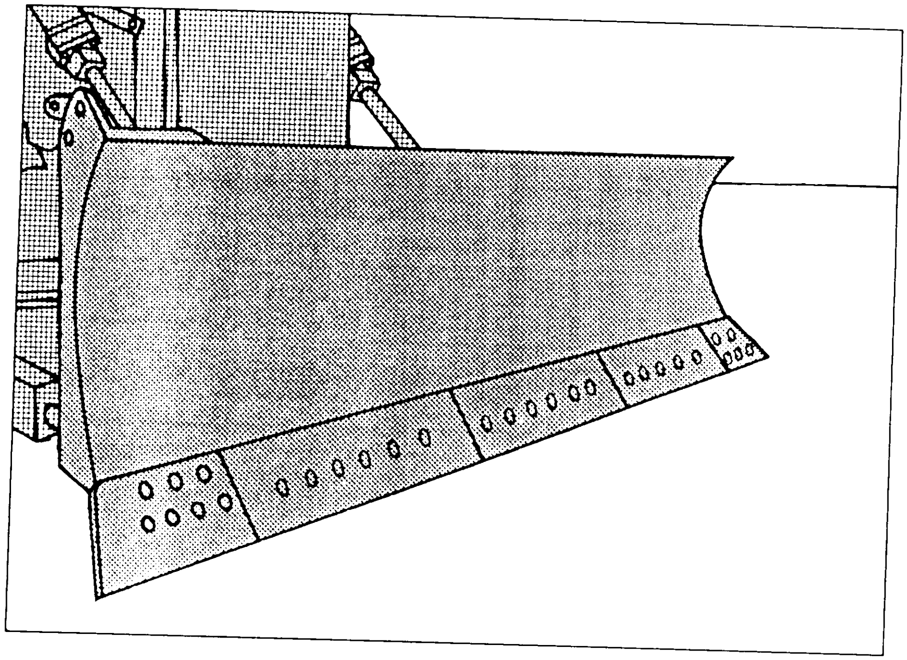


Figure 11-18.—Angle blade.

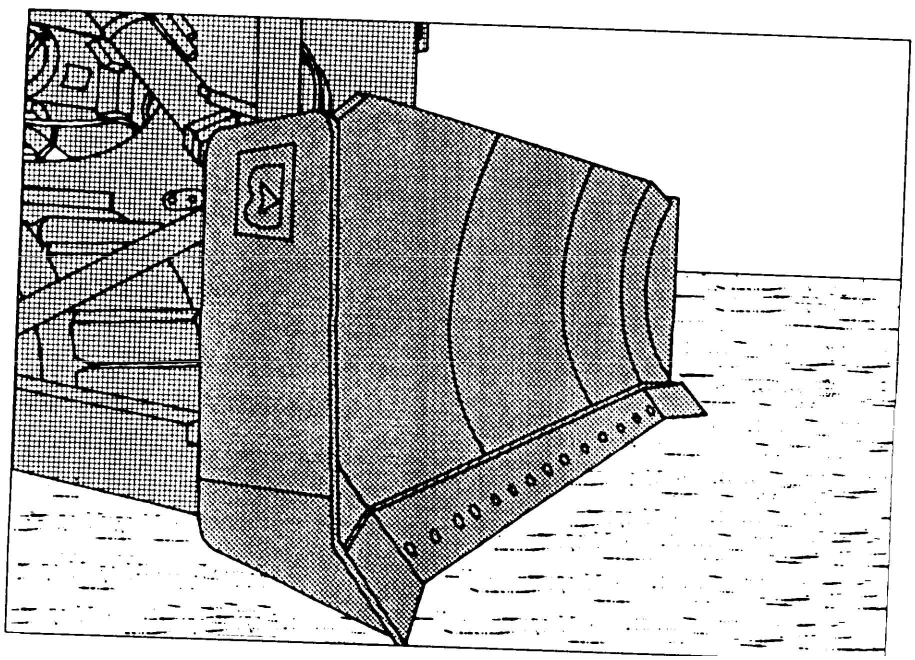


Figure 11-19.—"U" blade.

be drifted short to medium distances. Blade curvature lifts the dirt high with a rolling action to lower resistance and speed drifting. These blades have the side advanced ahead of the center section and tilt up to 15 degrees, right and left.

ANGLE BLADE.— The angle blade (fig. 11-18) is a multipurpose tool that can be used for general dozing and for the side casting of materials. The angle blade can be positioned straight ahead or angled 25 degrees to either side. The moldboard has a greater curve than a straight blade to produce more rolling action.

"U" BLADE.— The "U" blade (fig. 11-19) drifts large volume loads efficiently over long distances. The center section lifts material high with a forward roll. The side sections are angled so they lift and roll materials inward, keeping the load centered with a minimum loss of material to the side. This type of blade has the sides well advanced ahead of the center section, causing a "U" shape. It may also be tilted 15 degrees, right or left.

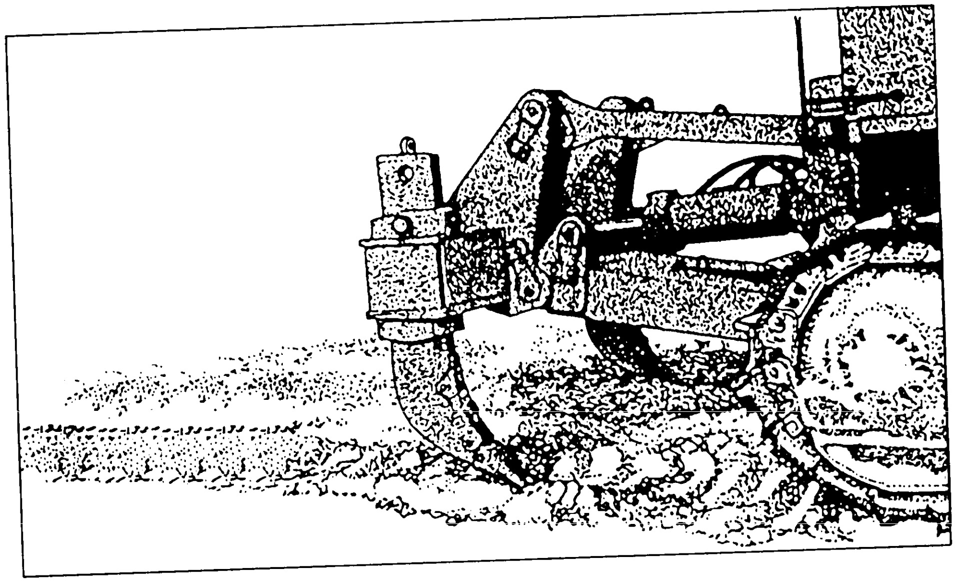


Figure 11-20.—Ripper attachment.

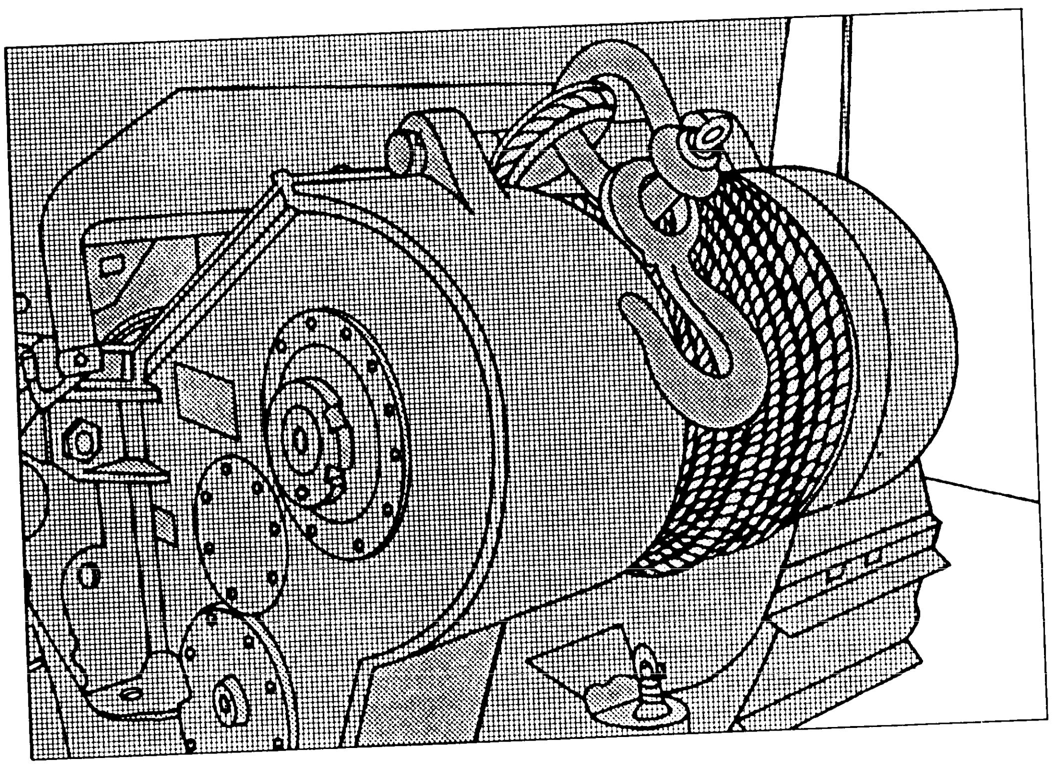


Figure 11-21.—Winch attachment.

Rippers

The ripper attachment is mounted on the rear of the dozer (fig. 11-20). The ripper is a powerful tool used to break up compacted materials; to uproot boulders and stumps; to loosen shale, sandsstone, and asphalt pavement; and to rip up concrete slabs. After these materials are uprooted or ripped, they can be removed easier by supporting equipment.

NOTE: Care should be taken when turning with the ripper teeth in the ground, because damage to the ripper teeth and assembly can occur.

Winches

A winch is mounted on the rear of the dozer (fig. 11-21) and is directly geared to the rear power takeoff. This arrangement permits development of a line pull that is 50 to 100 percent greater than straight dozer pull. The winch is used for uprooting trees and stumps, hoisting and skidding felled trees, freeing mired equipment, and supporting amphibious construction operations.

Some limitations to consider when performing winch operations are the pulling capacity of the winch and the size and weight of the dozer. Also, the terrain may affect maneuverability of the dozer.

WARNING

The breakage of the wire rope is a serious hazard to both the operator and the helpers. Wire rope stretches under strain; and if it breaks, it whips with great force. The danger to the operator is greatest if the operator and dozer are in direct line with the wire rope when it is under strain. When the wire rope is under strain, **everybody in the area should stand clear of the full length of the paid-out wire rope.** When rewinding the wire rope back onto the winch drum, ensure riggers hands are clear of the winch drum by at least 3 feet. Be safety conscious and ensure the wire rope used is of the best quality and meets the manufacturers' specifications and is properly inspected before use. Always wear leather-palmed gloves when handling the wire rope.

A good practice is to work a winch at less than its maximum capacity and to avoid anchoring the dozer unless absolutely necessary. Moderate loads give long life to the wire rope and winch parts and avoid severe catching on the drum. If the work is heavy, strain can be reduced by the use of pulleys and multiple lines. When pulling from the winch, always be sure to pull straight off the winch. When wire rope is pulled from an angle, it slips sideways, possibly causing damage to both the wire and winch.

OPERATING TECHNIQUES

The dozer blade is hydraulically controlled by a lever in the operator's cab. Before starting, raise and lower the blade several times to get a feel of the hydraulic control. Start all jobs, if possible, from relatively level ground. If necessary, level an area large enough to provide sufficient working space for the dozer. This prevents back-and-forth pitching of the dozer and results in better blade control.

Avoid track spinning whenever possible; this wastes effort and only converts a relatively smooth working area into ruts and piles of material that pitch and tilt a tractor. In cold weather, ruts and piles freeze and cause additional difficulty the following workday. If it rains, the ruts hold the water, resulting in wet, muddy material.

Ditches, ridges, rocks, or logs should be crossed slowly and, impossible, at an angle. his procedure slows the fall, lessens the danger of upsetting the dozer, and reduces the jolt of the fall that can be harmful to both the operator and the dozer.

When dozing, shift the dozer into low gear and feed the blade into the ground gradually until the desired depth of the cut is obtained. When you feel an increase in resistance as the load increases, start raising the blade in small increments, about one-quarter inch at a time. If you raise and lower the blade as much as 2 or 3 inches at a time while operating, the blade cuts an uneven surface over which the dozer must travel. The uneven surface will cause the dozer to nose up and down. This causes the blade to cut still more unevenly, thereby increasing the up-and-down movement of the dozer.

To carry the load with the blade, you must anticipate and compensate for the up-and-down movement of the front of the dozer. When the front of the dozer starts to nose up, you should move the control lever in the direction that will lower the blade. When the dozer starts to nose down, raise the blade high enough to compensate for the lowering of the front of the dozer. Do not over control. Raise and lower the blade only enough to compensate for the raising and lowering of the front of the tractor. Through experience, you will be able to raise and lower the blade automatically without giving it much thought or special attention.

Clearing

Clearing consists of removing brush, trees, and rubbish from a designated area. Surface boulders and other material that may be embedded in the ground should also be removed as well as any material that may interfere with the construction project.

BRUSH AND TREES.— To clear brush and small trees with a dozer, travel forward at a slow speed with the blade lowered several inches below grade, as shown in figure 11-22. When cleared in this manner, make one pass to knock over small trees and brush, then make another pass to clear them away.

Medium trees are 4 to 10 inches in diameter. To push trees of this size, raise the blade as high as possible

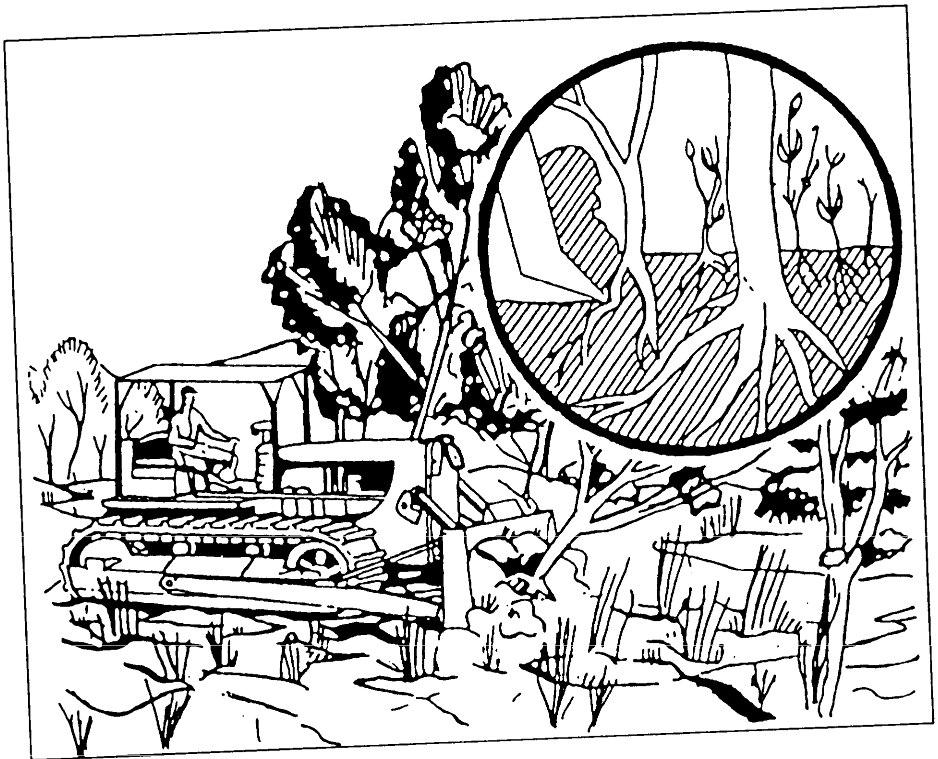


Figure 11-22.—Clearing brush and small trees.

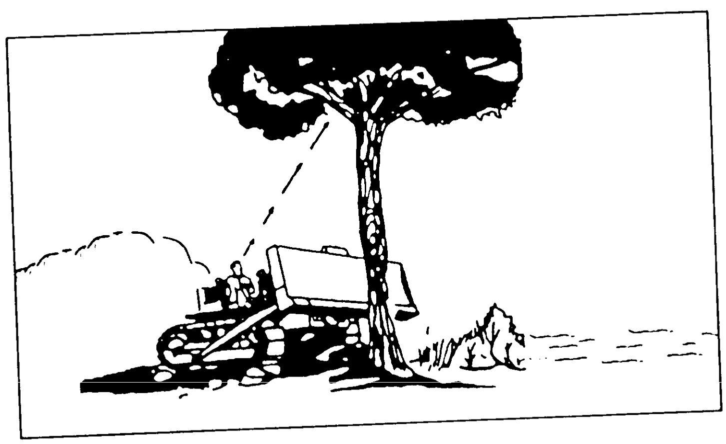


Figure 11-23.—Pushing over a medium-size tree.

to gain added leverage and push the tree over slowly, as shown in figure 11-23.

As the tree falls, backup quickly to clear the rising root mass. Lower the blade, travel forward, and dig the roots free with a lifting and pushing action. The felled trees are then ready to be pushed to a dismissal area.

Large trees are over 10 inches in diameter. For large trees, the removal is slower, more difficult, and takes more time. Approach the tree on foot and inspect it for dead limbs that could break off and fall on the dozer, possibly hitting the operator. Then make sure the dozer blade contacts the tree high and centered for the most leverage. Before pushing over a large tree, determine the direction of the fall, which is usually in the direction of lean. If the tree can be pushed over in the manner described for medium trees, do so.

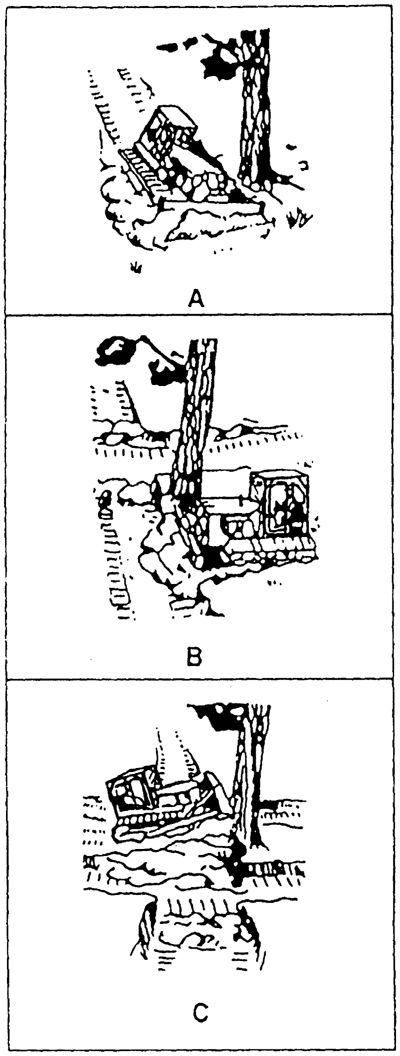


Figure 11-24.—Large tree removal.

If the tree has a large root system, the following method may be used: A cut is made on the side opposite the direction of fall of the tree to a depth sufficient to cut some of the larger roots (fig. 11-24, view A). The roots on both adjacent sides are cut in a similar manner (fig. 11-24, view B). Build an earth ramp above the original cut, so a greater pushing leverage can be obtained to push the tree over (fig. 11-24, view C).

As it starts to fall, back quickly to get away from the rising root mass. It may be necessary to cut the roots on the fourth side when large- or well-rooted trees are being removed. The cut around the tree should have a "V" ditch shape, made with the blade angled downward laterally toward the tree to cut the roots. The stump holes should be filled so water cannot collect.

CAUTION

When removing trees, be careful not to injure personnel or damage equipment. See that the dozer has side covers for [he engine. These covers help prevent limbs, sticks, and other debris from entering the engine area.

Dozers should never be worked close together when clearing trees, because one dozer could push a tree over on the other. Do not follow too closely when the tree starts to fall, since the stump may catch under the front of the dozer. The dozer will then need help backing off, and the bottom of the dozer could be damaged. As the operator, you should have a plan of how you are going to accomplish clearing the trees so they do not tangle with one another when they fall. You will probably be pushing green trees. They bend and snap back when free and may damage equipment or injure personnel. When making contact or releasing pressure on the tree, do it slowly so the top of the tree does not sway or shake, causing dead limbs to break off and fall on the dozer, possibly hitting you.

Know the ground on which you are working. Do not **high center** the dozer on stumps or trees. This problem is tougher when you are working in a wooded area and need help from another dozer. Existing trees could interfere. When you are clearing brush and trees, remember that the most common cause of damage to a machine is a stick or limb puncturing the radiator, breaking a hydraulic line, or damaging the exhaust stack. Pay attention. Know the capabilities of your dozer and what you need to do from start to finish.

STUMPING.— Pushing down a whole tree with a dozer is easier than removing the tree first by cutting it down and then removing the stump. The stump is usually too short to gain any pushing leverage or to provide a good swaying action for breaking out the roots.

When removing a stump, side cut deep enough to get the blade well under the roots. You can break up the roots by placing the blade well under the stump, traveling forward and raising the blade.

For a stump that will not yield to dozing, hauling it out with chains and grab hooks pulled by several dozers may work; or the stump may be hauled out by a wire leading to the winch on a winch-equipped dozer. If the ground around the stump is not to be disturbed, you may only need to saw the stump off level with the surface grade, rather than removing it.

REMOVING ROCKS AND BOULDERS.— A dozer with a tilted blade is the most effective piece of equipment for removing rocks and boulders. With the left lower corner of the blade hooked well under the boulder, the best way to exert maximum uprooting pressure is to combine raising the blade with a right turn of the dozer. With the right lower corner of the blade hooked well under the boulder, the best way to exert maximum uprooting pressure is to combine raising the blade with a left turn of the dozer. A boulder that is deeply embedded should beside cut, like a stump. Some boulders, like some stumps, must be broken up some other way for removal. If the dozer is not equipped with a hydraulic tilt control, the dozer blade can be tilted by adjusting the pitch braces on the blade of the dozer to lower either corner of the blade. To increase the digging action of a straight-blade dozer working in hard ground, tilt the top of the blade forward.

WORKING IN WET MATERIAL.— Wet material is quite difficult to move with a dozer. When the material is too soft to hold up the weight of the dozer, each successive pass should be the full depth of the wet material. This places the dozer on a firmer footing. The mud should be pushed far enough so it will not flow back into the cut. Provide for rescue of the dozer if the dozer gets stuck.

NOTE: Never pull a dozer forward by hooking onto the blade. The blade is made for pushing, not pulling, Hook the towing wire rope to the hook under the front of the tractor or to the drawbar on the rear of the tractor. Some dozers are equipped with wider track shoes for better flotation when working in mud or soft materials. These tractors with wide track shoes are called low ground pressure (LGP) tractors.

The extremely low ground bearing pressure is one of many reasons the dozer is highly recommended for working in wet materials.

Bulldozing

Bulldozing (drifting) is the process of pushing materials straight ahead in front of the dozer blade. Bulldozing is most efficient when the blade pushes as much material as possible, as shown in figure 11-25. The maximum working distance for dozer production depends on the speed and blade capacity of the dozer. However, the maximum working distance is usually 200 to 500 feet with 300 feet being normal for a medium-size dozer.

To maximize the amount of material pushed, push downhill whenever possible. With the assistance of gravity, a bulldozer can push a far greater load downhill than on a level grade. When you are dozing down a steep hill, a separate full-length pass with each load is unnecessary; instead, push and pile several loads at the brink of the hill and push them all to the bottom in a single pass.

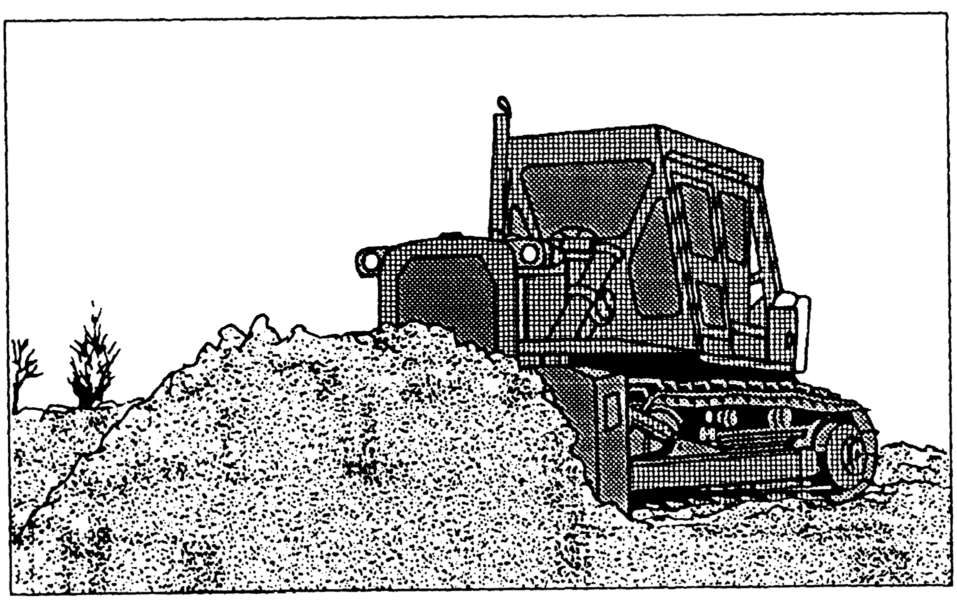


Figure 11-25.-Bulldozing.

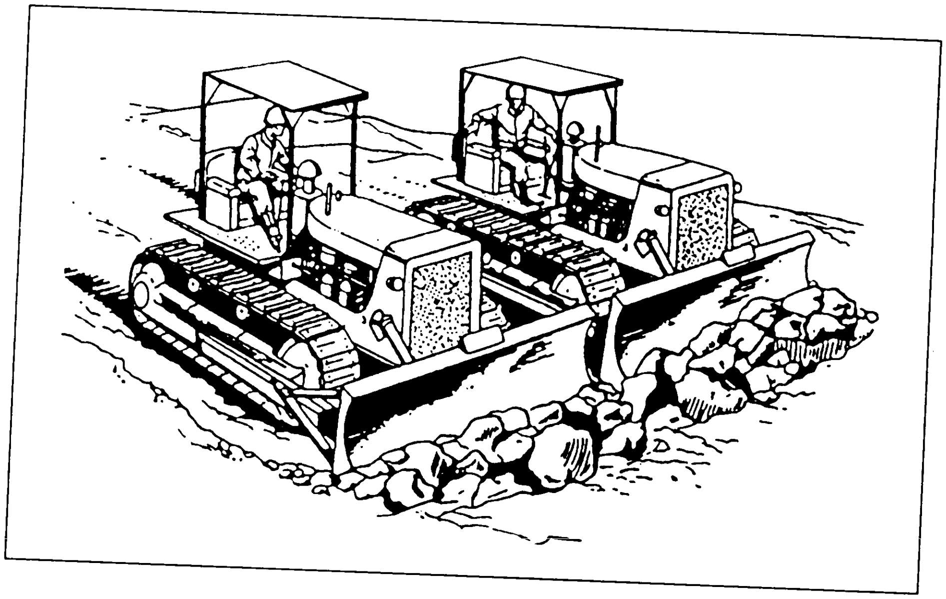


Figure 11-26.-Side-by-side dozing.

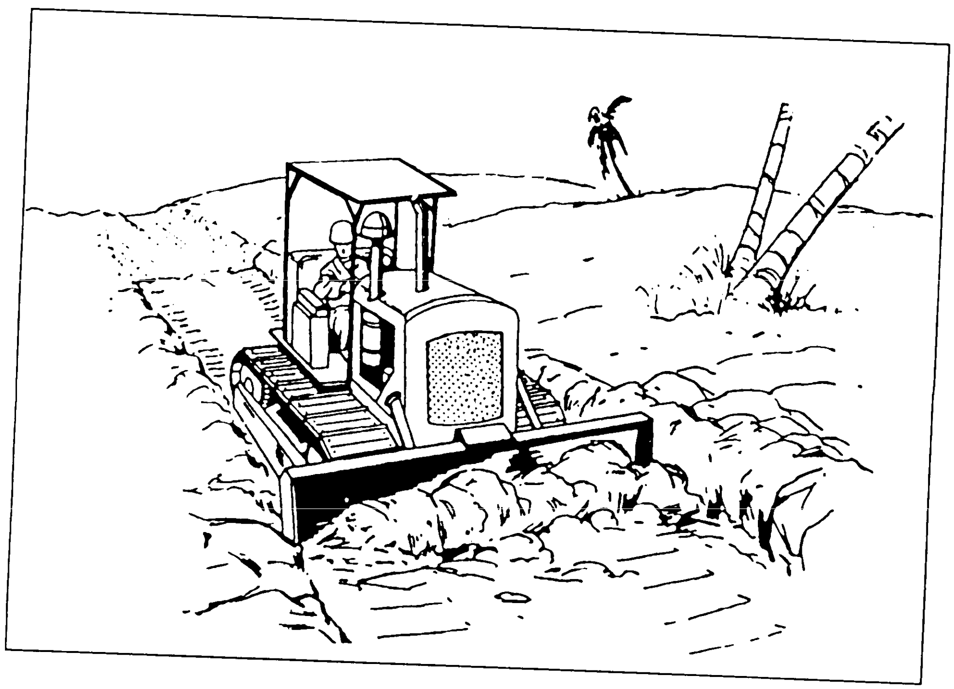


Figure 11-27.-Slot dozing.

Side-by-side dozing (fig. 11-26) and **slot dozing** (fig. 11-27) maximize the amount of earth drifted by reducing or preventing spillage around the outer edges of the blade.

SIDE-BY-SIDE DOZING.— In side-by-side dozing, two dozers work abreast with blade edges as close together as possible, preventing spillage around one blade edge on each dozer. Side-by-side dozing requires time-consuming maneuvering of the dozers; therefore, it is impractical for hauls of less than 50 feet and more than 300 feet.

SLOT DOZING.— Slot dozing is done by first building a pair of windrows with the spillage of several passes. As shown in figure 11-27, the windrows serve as barriers to prevent spillage around the dozer blade ends. Under favorable conditions, slot dozing can increase production up to 50 percent.

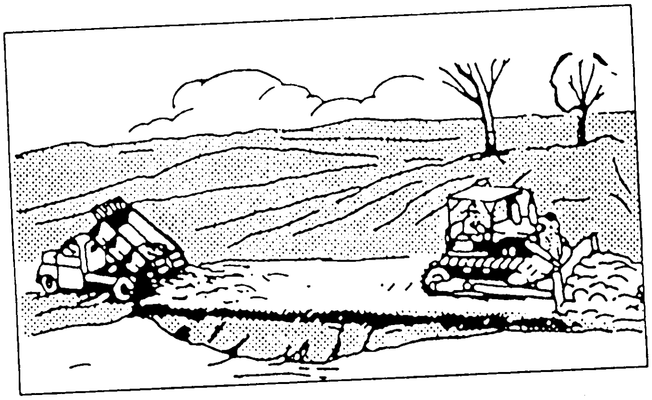


Figure 11-28.-Spreading.

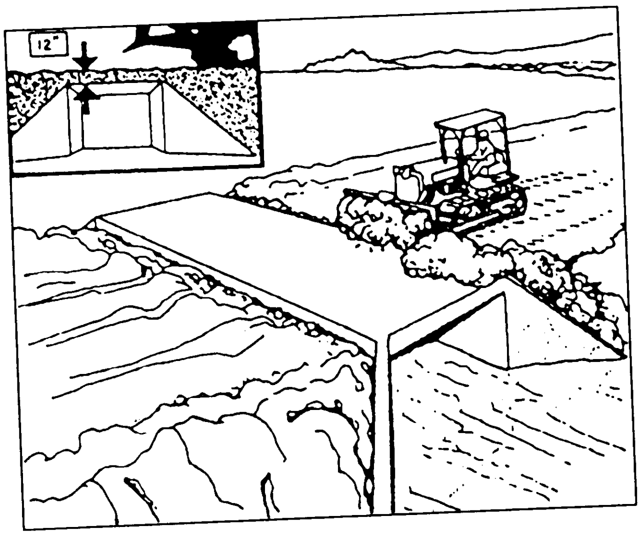


Figure 11-29.–Culvert backfilling.

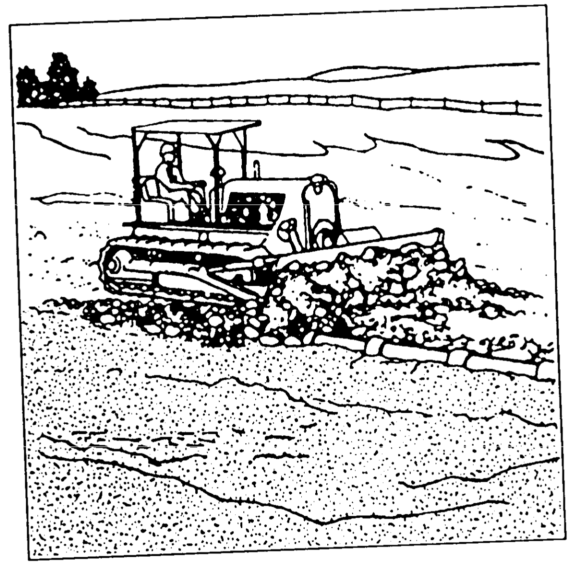


Figure 11-30.Trench backfilling.

SPREADING.— Dozers are ideal for spreading fill material brought in by haul units (fig, 11-28). Position the blade in a straight position, so the material is drifted directly under the cutting edge.

BACKFILLING.— Backfilling is the process of replacing excavated earth, as shown in figure 11-29. When a culvert is backfilled, the dozer should not cross the culvert unless there is at least 12 inches of compacted material on top of the culvert. If a bulldozer is used to bacfill a culvert, the best method is to make diagonal passes over the material, ending each pass with a swing that brings the blade in line with the culvert.

The **angle blade** is preferred for bacfilling a trench, because material can be side cast into the trench while maintaining a steady forward motion, as shown in figure 11-30.

When a pipe trench is bacfilled, fine material is placed around the pipe and coarse material above it, so the pipe is supported by well-compacted material. However, covering the pipe to full depth in short lengths may concentrate weight and break pipe joints; therefore, cover the pipe in successive layers, rather than all at once.

NOTE: Be careful in pipe trench bacfilling to avoid dropping large rocks directly on the pipe.

FINISHING.— Whether clearing or spreading material on a roadbed, no job is completed until it has been smoothed and drainage is established. This is called **finishing** and should be done at the end of each Shift.

Blade the job lightly with about a half of a blade of dirt. This fills in any low spots or holes. Leave a windrow on the side that you are working toward. At the start of the next pass, cover half the blade width. Continue in this fashion over the project or section of the project you have worked that day before you shut down for the day. Finishing the project in this manner supports drainage and prevents having to walk over piles of dirt or through mudholes.

Ditching

Rough ditching can be done with a dozer by making a series of overlapping passes at right angles to the line of the ditch. A "V" type of ditch can be dug with a dozer as follows: First, buildup a windrow along the edge of

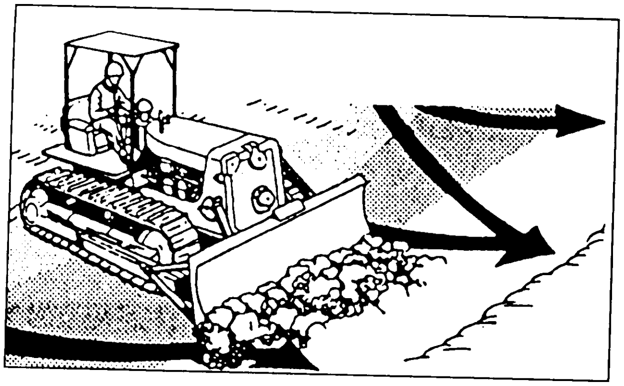


Figure 11-31.—"V" ditch construction.

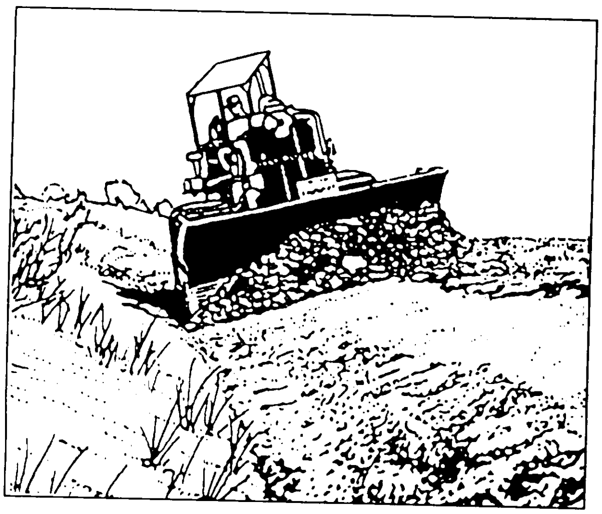


Figure 11-32.-Angle blade ditch cut.

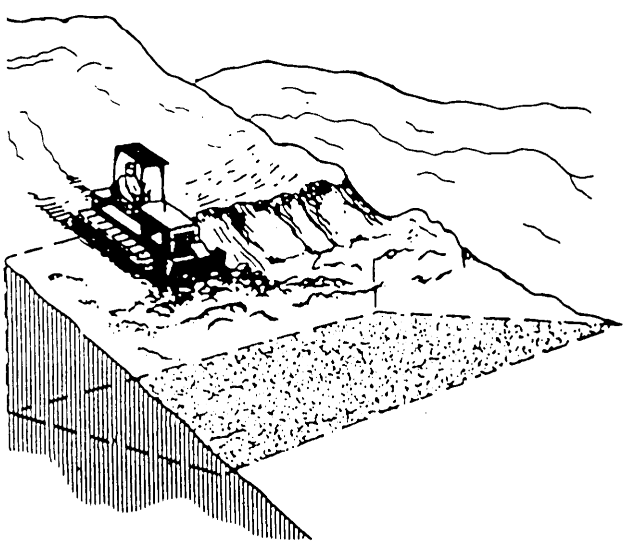


Figure 11-33.—Bench cut.

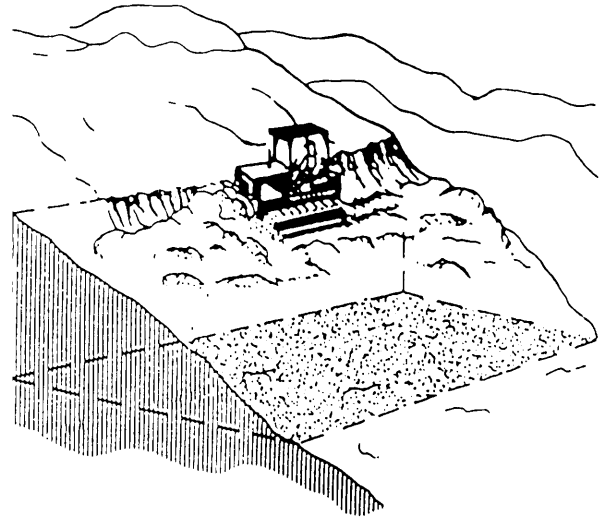


Figure **11-34 .-Sidehill excavation.**

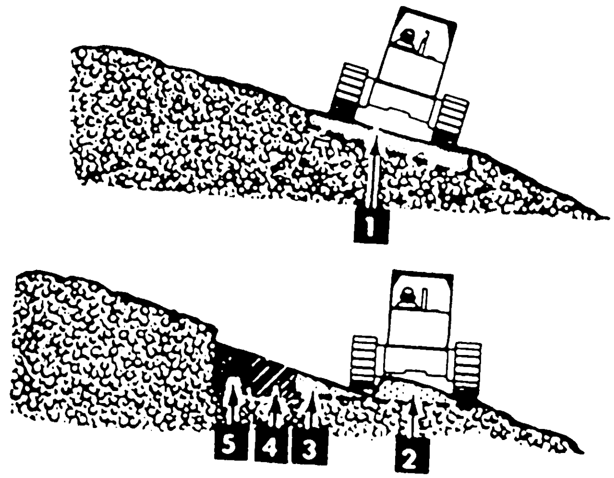


Figure 11-35.-Shallow slope sidehill excavation.

the ditch (fig. 11-31). Then turn the machine parallel to the line of the ditch, get the outside track on the window, and make a pass along the windrow. With the outside track elevated by the windrow, the blade cuts one side of a "V" type of ditch. Cut the other side the same way.

An **angle blade** is preferable for digging a "V" type of ditch for two reasons: (1) you can side cast the windrow in a single pass and (2) the angled blade will side cast the material to the sides of the ditch as you travel along the windrow, as shown in figure 11-32.

Sidehill Excavation

A sidehill excavation can be started more easily if a small bench cut is made first, as shown in figure 11-33. When digging the sidehill, keep the inside (uphill) surface slightly lower to gain greater tractor stability (fig. 11-34). Tilting the blade produces this type of cut.

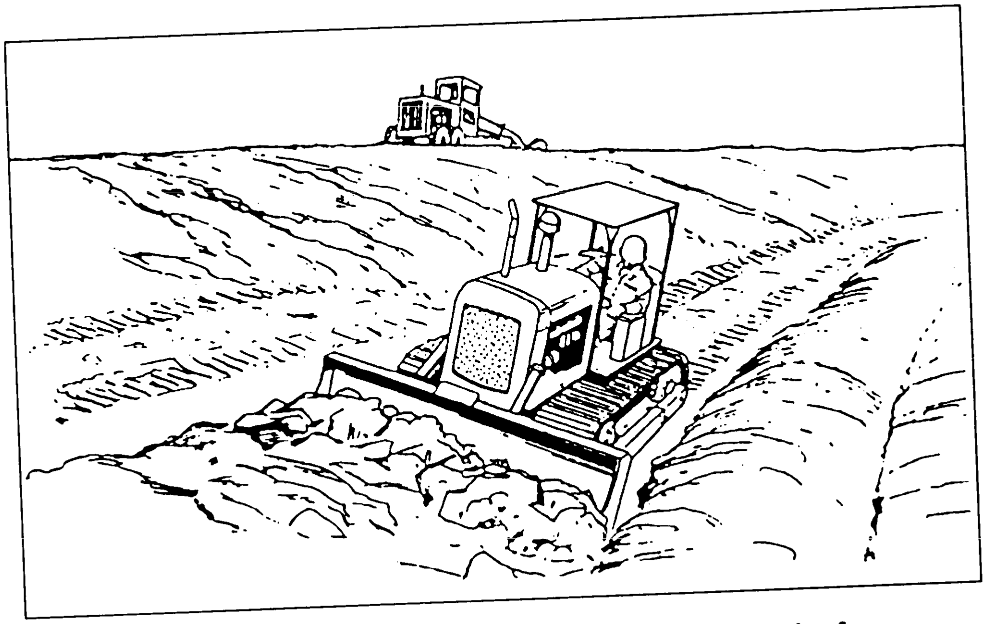


Figure 11-36.–Finishing a side slope by working parallel to the right-of-way.

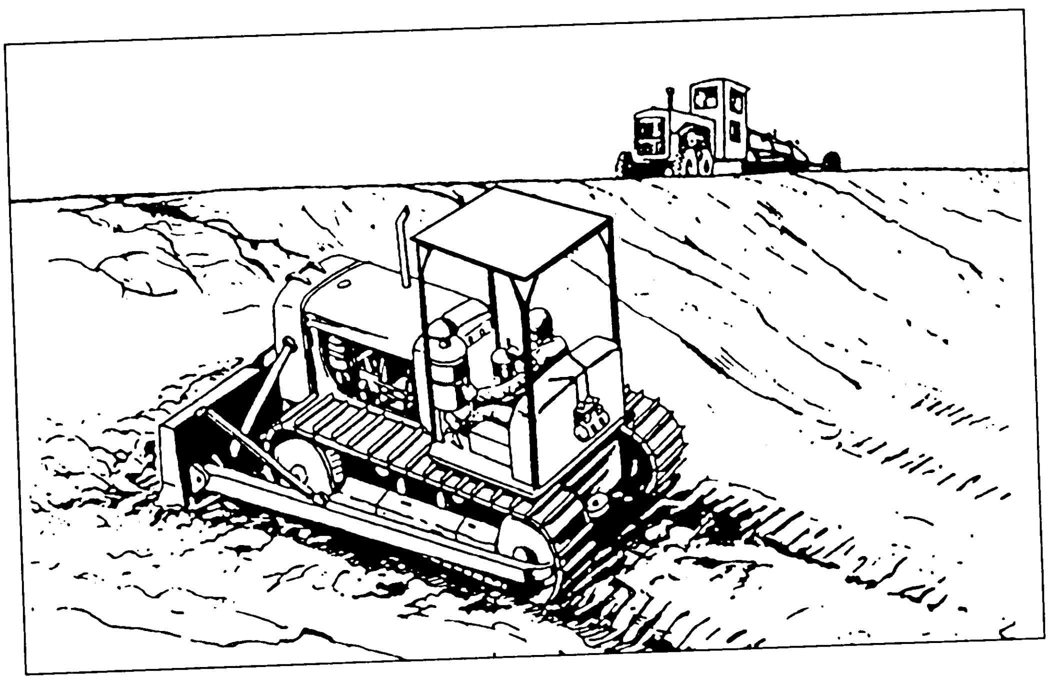


Figure 11-37.–Finishing a side slope by working diagonally.

Always cut the shelf wide enough to provide solid support for equipment that will be used later. If possible, move the material downhill to gain the advantage of gravity, to reduce effort, and to increase the stability of the dozer.

On shallow slopes or in soft soil, the sidehill cut can be made, as shown in figure 11-35, cuts 1 and 2.

Stability is increased by running the uphill track inside the ridge left by the first cut. Cuts 3, 4, and 5 show the completion of the shelf. Pushing the loosened material to the lower side of the slope normally reduces the time required to complete the cut. Do not push the material beyond the point required to retain firm track support. When you are backing up, do not raise the blade, as this puts extra weight on the front idlers, causing greater track penetration. Let the blade float as you back away from the edge of soft fills.

Finishing Side Slopes

Two commonly used methods for finishing side slopes with dozers are shown in figures 11-36 and 11-37.

When side slopes are finished by working parallel to the right-of-way (fig. 11-36), the dozer starts at the top. Material from each pass falls to the lower side of the blade and forms a windrow that is picked up on succeeding passes, filling irregularities in the terrain. Do not allow the blade corner to dig, since this steepens the slope beyond job specifications. In finishing side slopes by working diagonally, start the dozer at the bottom and work diagonally up the slope (fig. 11-37). A windrow is formed and is continually drifted to one side, tending to fill low spots or irregularities.

NOTE: Diagonally finishing a side slope is one of the few instances when a dozer maybe used efficiently in cutting upgrade.

Push Dozer

The push dozer in figure 11-38 is equipped with a push blade. However, in most cases, a straight-blade dozer that has a reinforced block in the center of the blade is used. Ensure the center lines of the pusher and scraper are aligned. If alignment is not centered, it is hard to keep the pusher straight without extensive use of the steering clutch. When you are using the steering clutch, power is taken away from one track, and the other track is doing all the work. If the scraper starts to jackknife, stop pushing, back up, and get repositioned straight with the scraper. Be sure the blade of the dozer does not cut the rear tires of the scraper, resulting in downtime and costly tire replacement.

Dozer Safety

Standard safety precautions that apply to dozer operations are as follows:

- Only operate the dozer at speeds at which control of the dozer can be maintained at all times.

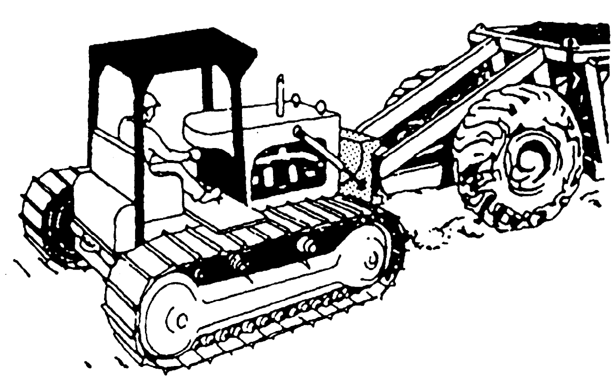


Figure 11-38.—Push dozer.

- Navy safety regulations require that all dozers be equipped with roll-over protective strictures (ROPS), crankcase guards, and radiator protectors. All dozers purchased by the Navy are equipped with these devices. Dozers must never be used without these devices in place.

- Always wear a seat belt when dozing. A sudden jolt from working on uneven terrain can possibly throw you off the machine or against the control levers, causing serious injury or death.

- Obtain a digging permit before performing excavation operations with a dozer.

- When using a dozer for demolition, take care to prevent falling objects from striking the operator or other personnel.

- When felling trees with a dozer, take care to avoid being struck by falling branches or by the backlash of a branch or trunk.

- A dozer should never be used for clearing trees without being equipped with an operator's protective cage (brush cage).

- Personnel must never ride the dozer drawbar. his dangerous practice has been the cause of numerous accidents.

- Operators of dozers and rippers should make every effort to learn the locations of any underground high-voltage electric lines or gas lines that might be contacted by their equipment.

- Operate the dozer from the sitting position, never from a standing position.

- A dozer must be operated with extreme care when near the edge of a cut; the edge may give way, overturning the machine.

- A steep incline should be climbed slowly. "Gunning" up a steep slope has often caused dozers to overturn.

- Do not attempt a turn on a steep slope. Sliding sideways may not appear to be dangerous, but it can easily become so if the low side of the dozer hits a solid rock or a stump.

- Coupling trailing equipment to a dozer is hazardous; be especially alert while this is being done. Whenever possible, equipment should be coupled with the dozer stopped and the clutch, if so equipped, disengaged. Additionally, set the brake, and lower the blade.

- When towing a heavy load downgrade, keep the dozer in low gear. Coasting is dangerous. A coasting dozer with a towed load is likely to jackknife.

- Before dismounting a dozer and at the end of a workday, secure the dozer blade by lowering it to the ground. Lowering the blade prevents the dozer from rolling; more importantly, it eliminates the possibility of the blade falling on someone. Whenever it is necessary to work on the dozer with the blade up, especially when changing cutting edges, the blade must be securely blocked to prevent it from falling accidentally.

-

such as steel toe safety shoes and hard hats.

ROLLERS

Any time soil is disturbed, it becomes expanded and very loosely packed. During the construction of a fill or subgrade, this loose soil must be compacted into a solid mass. The process of compressing The loose soil into a solid mass is called compaction. If the soil is not properly compacted during construction, it will settle causing roads, building foundations, or runways to collapse.

Soil may be compacted naturally (settled) by weather and time. If the soil is porous, settlement may be speeded by soaking it and allowing it to dry. This process is slow and cannot be depended upon to produce the high densities required by project specification. Another method of compaction is through chemical stabilization that involves the application of one or more chemicals to a soil to achieve a desired change in its characteristics. Mechanical compaction is normally required to supplement chemical stabilization. To accomplish mechanical compaction, you can use various compaction techniques and types of compaction equipment, such as vibratory rollers, pneumatic-tired rollers, and steel-wheeled rollers.

VIBRATORY ROLLERS

Vibratory rollers provide compactive force by a combination of weight and vibration of their steel compaction rolls, commonly referred to as drums. Those used for compaction are self-propelled and vary in weight from 7 to 17 tons.

Propulsion for single-drum models is provided by pneumatic-tired wheels, as shown in figure 11-39. The

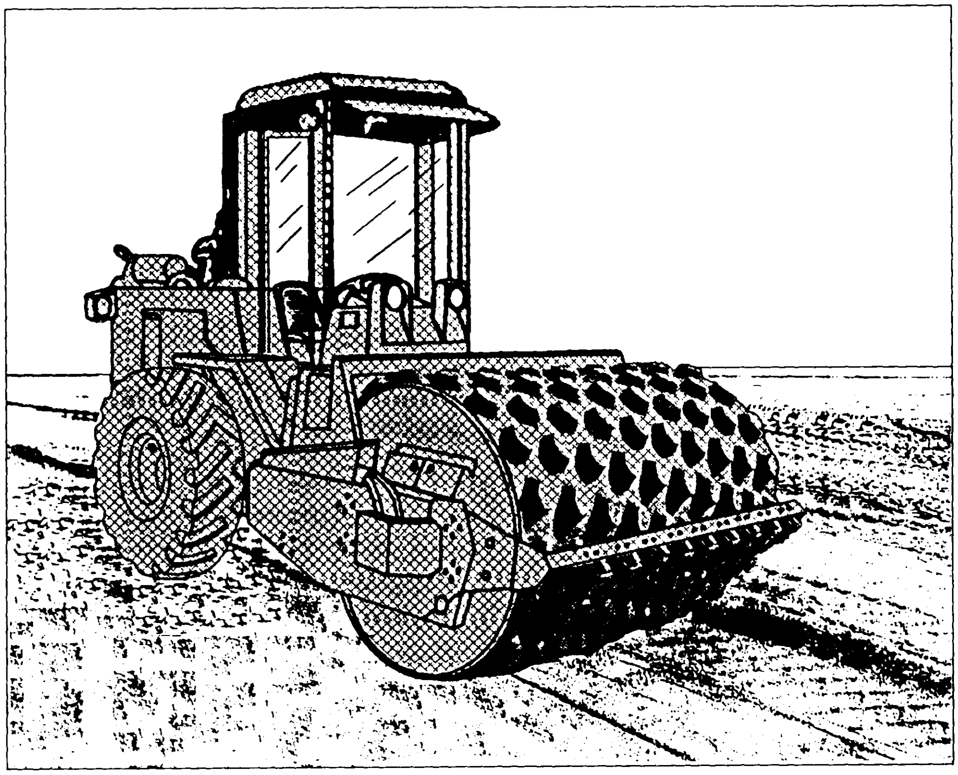


Figure 11-39.—Vibratory roller.

drums on vibratory rollers vary from 3 to 5 feet in diameter and 4 to 8 feet in width.

The engine, providing power for propulsion, also powers the hydraulically driven vibrating unit. Vibrations are generated by a rotating eccentric weight inside the drum, the speed of which determines the frequency, or vibrations per minute, of the drum. The weight and distance from the shaft of the eccentric determine the amplitude (amount) of the impact force. Both the frequency and amplitude of vibrations are controlled independently of roller travel and engine speed.

The vibration frequency of rollers used for compaction is generally between 2,000 to 3,000 vibrations per minute (vpm), depending on the model and manufacturer. Some models provide only one or two specific frequency settings; while others may provide a full range of frequencies within certain limits; for instance, 1,800 to 2,400 vpm.

Vibratory rollers achieve compaction through a combination of three factors: (1) weight, (2) impact forces (roller vibration), and (3) vibration response in the soil.

Weight

Weight is the natural force in compaction of soils. Vibrating rollers amplify their static weight through vibration to increase the overall dynamic weight.

Impact Forces

The impact forces are those generated by vibration of the compaction drum. They are regulated by controlling the frequency and amplitude of the vibration. The amount of impact force required to obtain optimum density depends on the type of material being compacted. The impact forces also vary with the diameter of the drum and the width and the ratio of the roller static weight and dynamic (impact) force.

Vibration Response

The vibration response in the soil or material is the result of the way the forces are exerted upon it by the vibratory roller. As with other types of rollers, the material will compact easily or with difficulty, depending on its moisture content, cohesion characteristic, particle shape and texture, and confinement; for example, sandy soil requires more vibration and less impact force (amplitude). However, a soil with higher clay content requires more amplitude than vibration because of the kneading action necessary to compact the clay. Vibratory rollers exert repetitive dynamic force on the material, rather than the static force used by other rollers.

The frequency and roller speed should be matched, so there will be at least 10 downward impacts per foot of travel of the roller. The speed of the roller increases for a given frequency of vibration, and the spacing of the impacts grows farther apart.

When using vibratory equipment, keep in mind that the energy imparted by the vibratory wheel must be absorbed in the material being compacted. Controlling the amplitude permits the operator to vary the force developed from the wheel and, therefore, the energy imparted to the material. A change in the lift thickness and material gradation content may require adjustment in the amplitudes being used.

NOTE: It is important that the roller vibrates only when it is moving. If vibration continues while the roller is standing still or changing direction, the vibrating drum will leave an indentation in the material at the stopping point.

Most modern rollers have automatic cutoffs for vibration when the roller stops moving.

The rollers used in the Naval Construction Force (NCF) are equipped with two interchangeable drums. One is known as the **sheepsfoot,** as shown in figure 11-40; and the other is known as a **smooth drum,** as shown in figure 11-41.

Sheepsfoot Drum

The sheepsfoot drum is used for compacting heavy lifts of 6 to 12 inches thick. As consecutive passes are made, the drum will start to walk out of the ground as the penetration of the sheepsfoots decrease. These rollers should only be used for initial compaction, because the footprints they leave will not allow excess water to drain.

These rollers concentrate the static and dynamic weight on the relatively small contact area of the sheepsfoots. This force is exerted through the one row of feet in contact with the ground. With all the roller weight concentrated on this row of sheepsfoots, they exert more than 22,000 pounds of force.

Smooth Drum

In most heavy fills, a smooth drum roller is worked behind the sheepsfoot drum and grader. With thinner

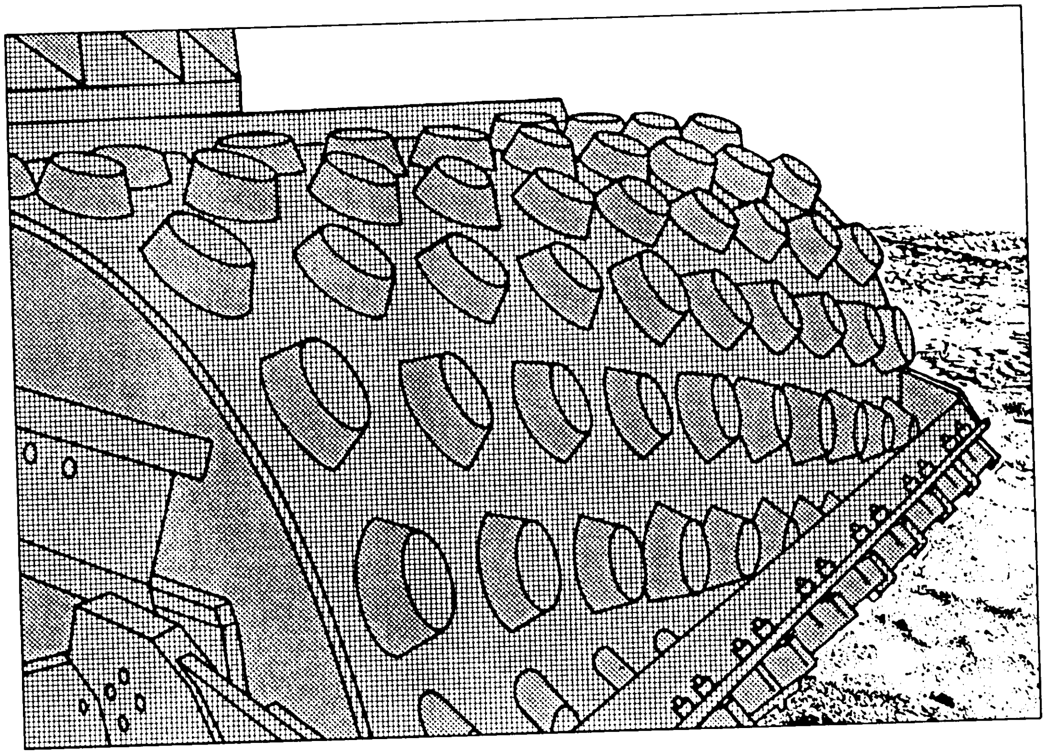


Figure 11-40.-Sheepfoot drum.

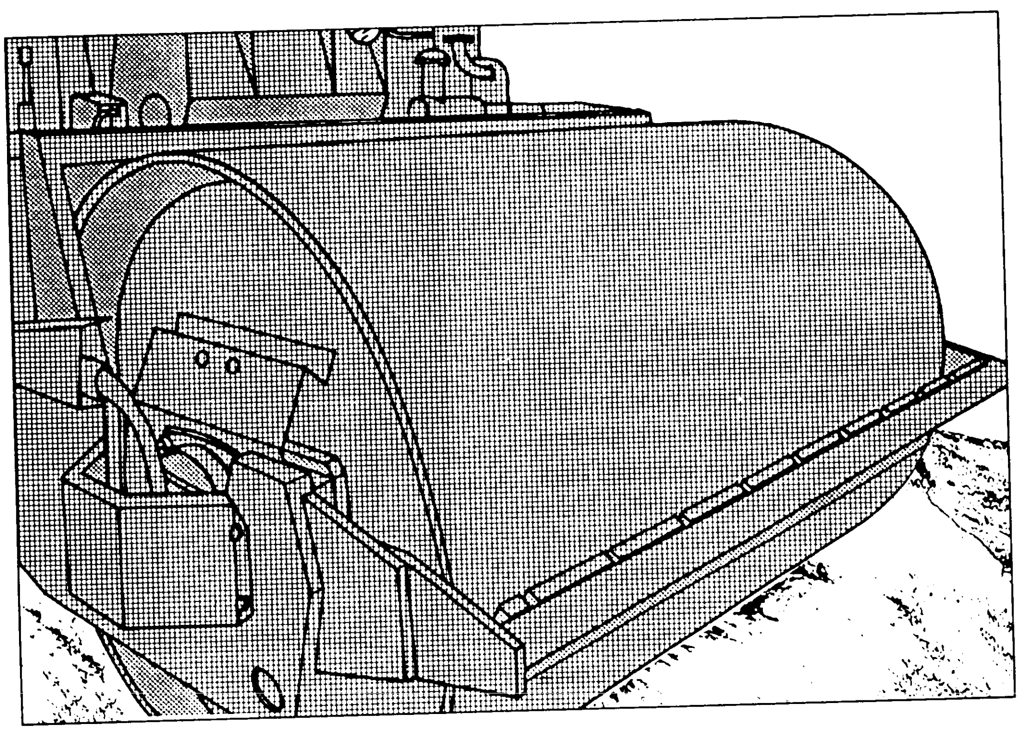


Figure 11-41.-Smooth drum.

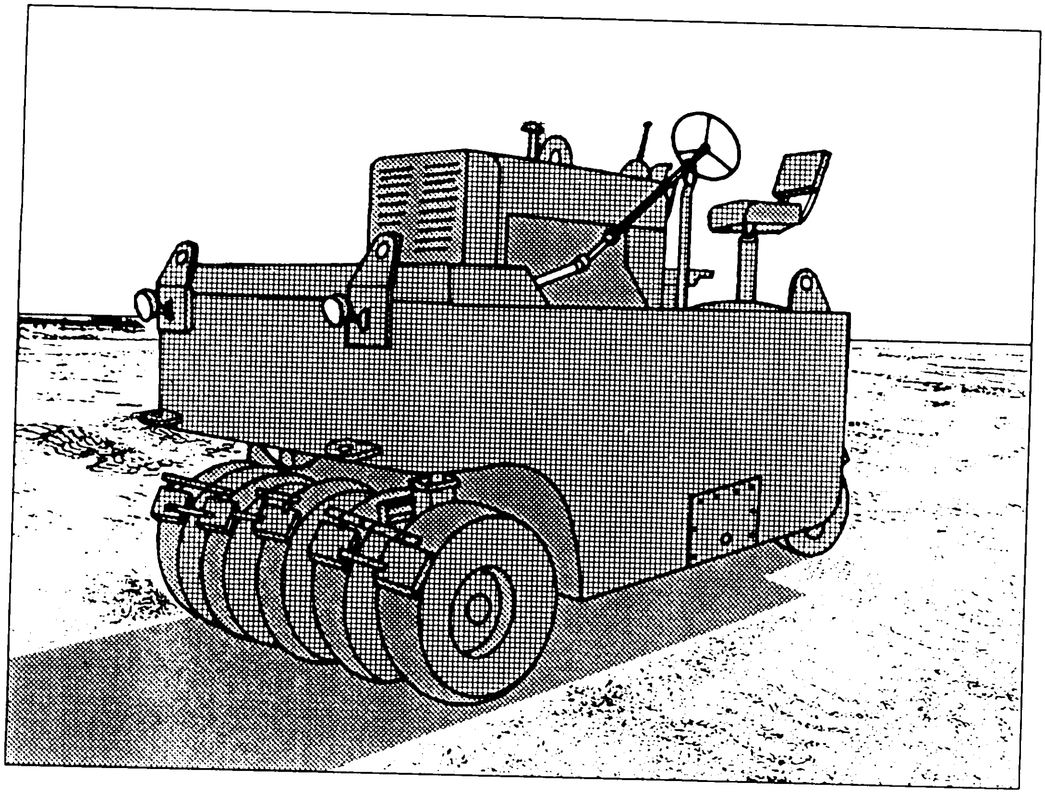


Figure 11-42.—Pneumatic-tired roller.

lifts, a smooth drum is all the compaction equipment required. The smooth drum compacts lifts of 4 to 8 inches and seals the surface to allow the excess water to drain. Unlike the sheepsfoot drum, smooth drum rollers concentrate the full width of the drum. The total dynamic force is slightly less, because more of the drum is in contact with the ground.

PNEUMATIC-TIRED ROLLERS

The pneumatic-tired rollers are widely used for compaction of subgrades, bases, bituminous mixes, and many types of material. They have rubber tires instead of steel tires or drums and generally feature two tandem axles, with three or four tires on the front axle and four or five tires on the rear, as shown in figure 11-42. They are aligned so the rear tires cover the spaces left between the tracks of the front tires. The tires are mounted in pairs that can oscillate, or singly with spring action, so tires can move down into soft spots that would be bridged by a steel drum. The rubber tires add to their downward pressure a **kneading effect,** as material is pressed toward spaces between the tires.

Pneumatic-tired rollers can be ballasted to adjust the weight. Depending on size and type, the weight may vary from 10 to 35 tons. However, more important than gross weight is the weight per wheel for the material being compacted.

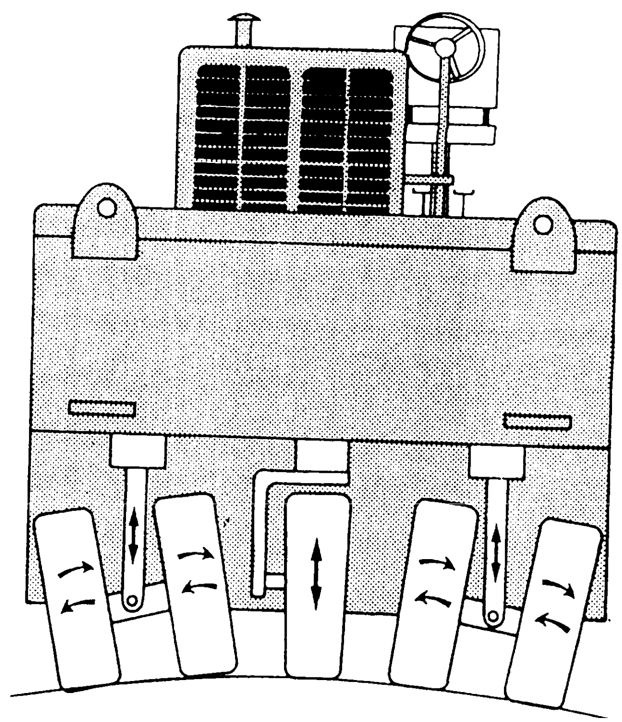


Figure 11-43.—Action of a pneumatic-tired roller.

CAUTION

Pneumatic rollers ballast with water are top heavy and are very unstable when operating on uneven terrain.

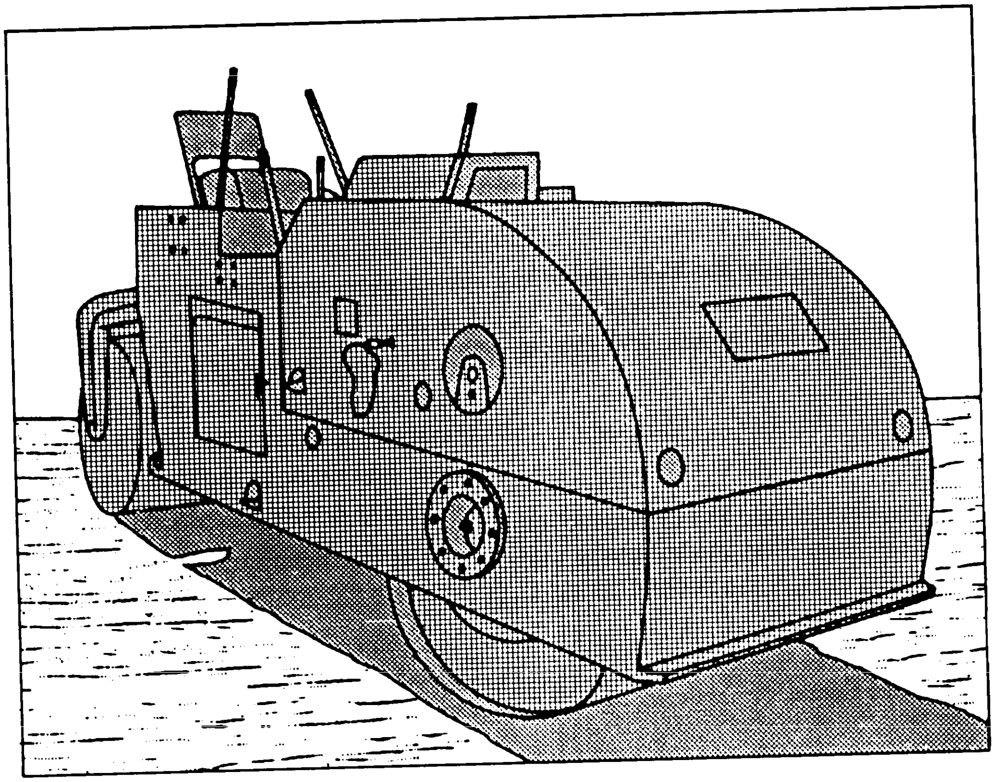


Figure 11-44.-Steel-wheeled roller.

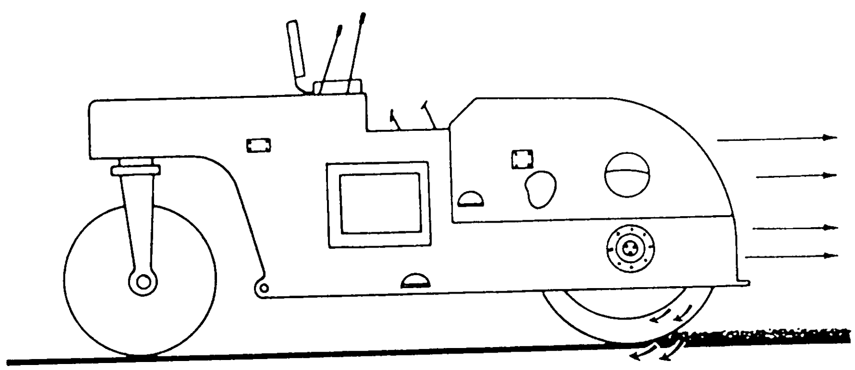


Figure 11-45.—Drive wheel rolling action.

Pneumatic-tired rollers may be equipped with 15-, 17-, 20-, or 24-inch tires. Air pressure in the tires may vary for different types of material, such as 50 to 60 psi to finish asphalt and 100 psi to compact a granular subbase. The tires must be inflated to nearly equal pressure with variation not exceeding 5 psi to apply uniform pressure during rolling.

Figure 11-43 shows the action of a pneumatic-tired roller. Pneumatic-tired rollers are used because the individual wheels can exert a kneading action in small areas that wide, rigid steel drums tend to bridge.

STEEL-WHEELED ROLLERS

A steel-wheeled roller, as shown in figure 11-44, is used for compaction and finish operations on base coarse materials and asphalt. This roller produces a smooth, solid surface under favorable conditions, but may fail to compact areas narrower than the roll, and do not compact deeply in proportion to their weight. The steel- wheeled roller does not change shape to bring suitable support for itself. Rather it sinks until enough bearing area has come in contact with the roll to support the roller weight.

The drive wheel is ahead of the tiller wheel in the direction of travel. The tiller wheel functions as the steering axle. As shown in figure 11-45, there is a downward vertical force caused by the weight or the wheel. The arrows, concentric with the steel wheel, represent the rotational force on the wheel. This force is transmitted to the base of the wheel, as the roller is propelled. This concentric force tends to move the material under the wheel, rather than to push it away. These forces result in a more direct vertical force than those of the forces under the tiller wheel.

ROLLING TECHNIQUES

Roller techniques arc basically the same with any type of roller. Some things you must consider are steering, changing direction and speed, and rolling sequence.

Steering

Steering sharply causes scuffing and damage to the surface; therefore, turns should be made slowly and gradually. You may have to back up several times to complete a turn.

Changing Direction and Speed

Starting and stopping should be done gradually to avoid scuffing the surface. Start stopping well ahead of the point where you want to stop. Engage the direction control slowly to avoid any wheel spin.

Rolling speed is 1 1/2 to 3 miles an hour. You must develop a rolling sequence to ensure the compaction is uniform throughout the fill.

Rolling Sequence

Overlapping is part of the rolling sequence. When rolling deep, loose fills, you should overlap at least half the drum width. Gradual extension of the rolled material into the unrolled area makes possible greater concentration of weight on local ridges and high spots.

In rolling a graded area with a side slope, as a crowned or banked road, you should work from the bottom to the top. The lower edges of the rolls have a tendency to push downhill, which can be best resisted by compacted material. In working uphill, the creep of soil away from the upper edge helps to preserve the slope.

A crowned road is rolled according to the pattern shown in figure 11-46, starting at one edge and working to the center line. Then move diagonally to the opposite side and work to the center line from that side. Each rerolling is done in the same manner.

It is efficient to roll in sections as long as you can overlap the sections, as shown in figure 11-47.

Banked or sloped elevated curves are rolled in the direction of travel, from the bottom (low side) to the top, as shown in figure 11-48. The rolling transition from the road crown to the bank curve is made by a diagonal from the center of the crown to the low side of the bank. The rolling transition from bank to crown is made straight to the adjoining low side of the road crown.

Rolling should be continued until no compaction advantage is noted on the fill from successive passes. Too much water in the fill material may make compaction impossible. This may require scarifying and windrowing the fill to aerate the material. A rubbery, or spongy, rolling action of the fill that springs back into nearly its original condition when the rollers have passed may indicate trapped water below the surface. The robbery, or spongy, area may require stabilization by other means, such as excavating the area and

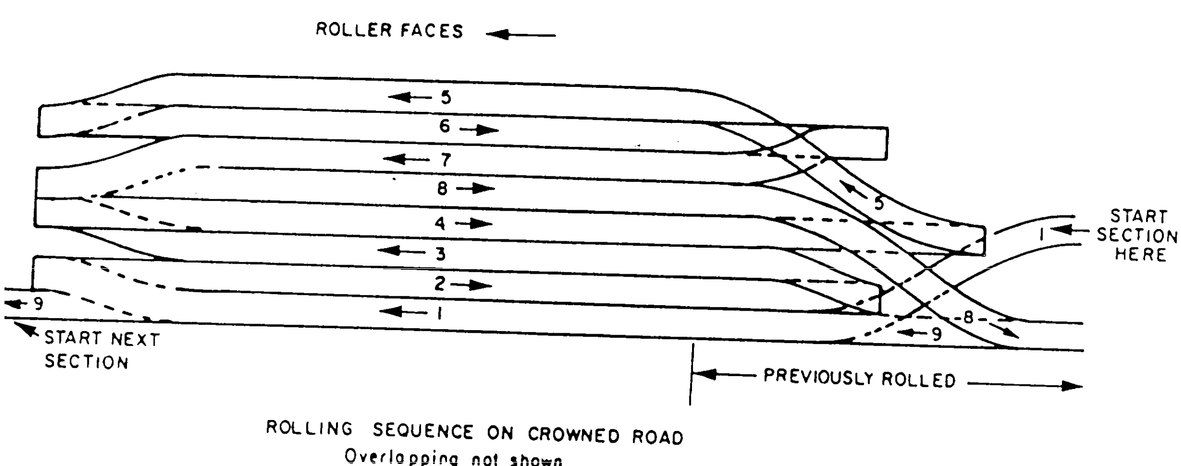


Figure 11-46.-Crowned road rolling sequence.

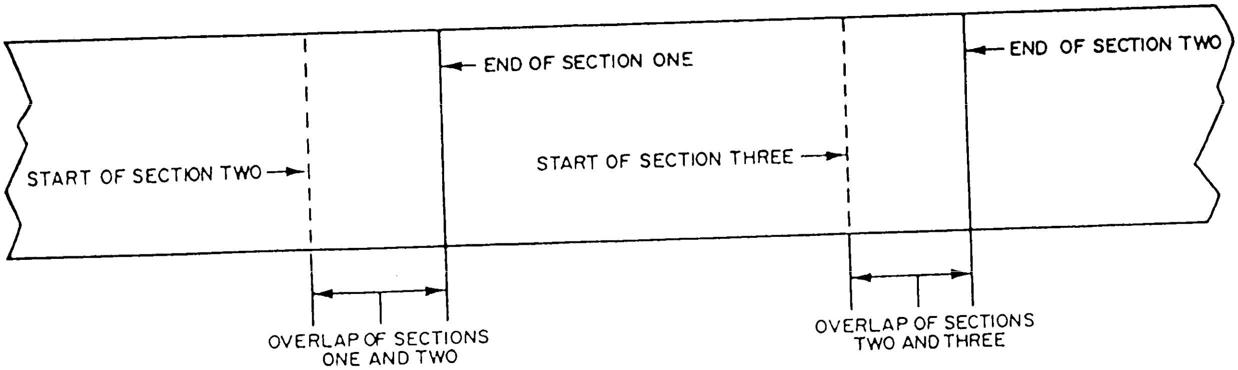


Figure 11-47.-Overlapping sections.

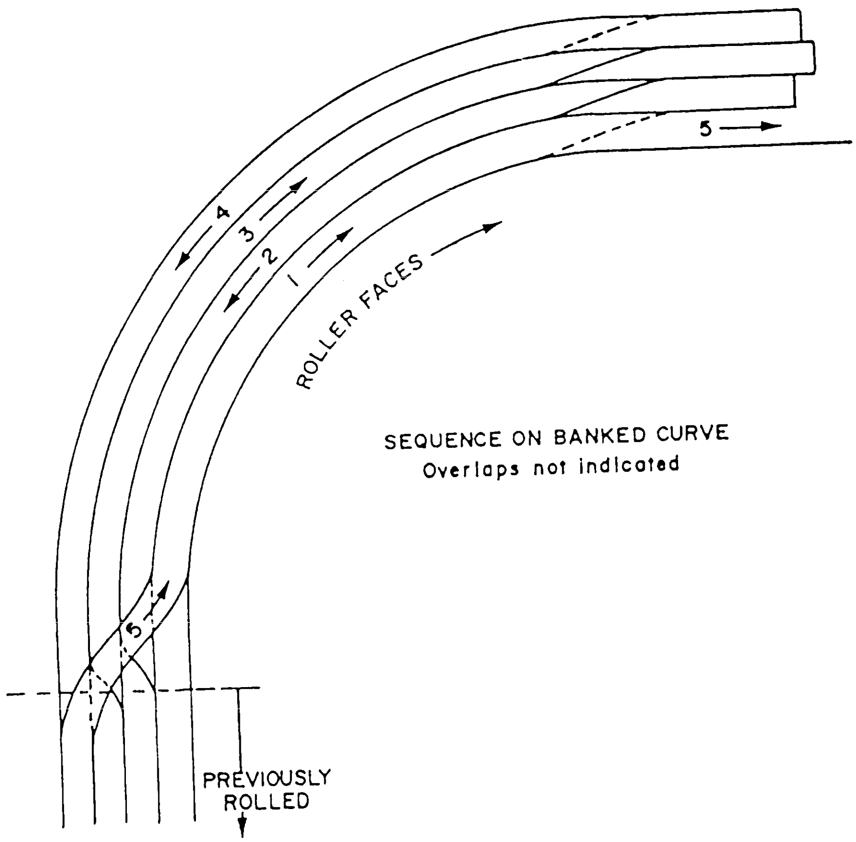


Figure 11-48.—Banked curve rolling sequence.

placement of riprap, soil cement, asphalt stabilization, and so forth.

BITUMINOUS ROLLING

Most of the compaction required in bituminous construction is achieved by the tamper on the asphalt paver. Additional compaction and final surface texture are achieved by applying the rollers in the proper sequence. The hot mix should be at its optimum temperature for rolling when the rollers start to operate on the mat being laid. This optimum temperature should range between 225°F to 285°F.

Rollers designed for bituminous operations are equipped with sprinklers that spray water on the smooth tires and drums. When you are rolling bituminous materials, the roller tires and drums must be moist with water to keep the bituminous materials from sticking. When water is not enough to keep the bituminous material from sticking, a non-foaming detergent is added to the water until the water has a soapy feeling.

NOTE: Do NOT use a detergent that is designed to break down grease or oil, as this will break down the petroleum products used in the bituminous mix.

NOTE: Ensure roller tires and drums are free of debris, such as sand, mud, dirt, and so forth, before rolling a hot bituminous mix.

CAUTION

Avoid prolonged skin contact with and inhalation of vapors from bituminous operations.

When you are rolling bituminous materials, the rollers should move at a slow, uniform speed with the drive wheels positioned toward the paver. The speed should not exceed 3 mph for steel-wheeled rollers or 5 mph for pneumatic-tired rollers. Asphalt rollers must be kept in good condition and should be capable of being reversed without backlash. The line of rolling should not be suddenly changed or the direction of rolling suddenly reversed, thereby displacing the mix. Any pronounced change in direction should be made on stable material.

Rolling hot bituminous mix is done in the following order:

1. Transverse joints
2. Longitudinal joints (when adjoining a previously placed lane)
3. Breakdown or initial rolling
4. Intermediate or second rolling
5. Finish rolling

As a guide, longitudinal joint and edge rolling should be performed directly behind the paver; breakdown rolling less than 200 feet behind the paver; intermediate rolling 200 feet or more behind the breakdown rolling; and finish rolling as soon as possible behind the breakdown rolling.

Transverse Joints

When a transverse joint is placed next to an adjoining lane, the first pass is made with a steel-wheeled roller moving along the longitudinal joint for a short distance. The surface is then straightedge and corrections made if necessary. The joint is then rolled transversely with all except 6 inches of the wheel width on the previously laid material (fig. 11-49). This operation should be repeated with successive passes

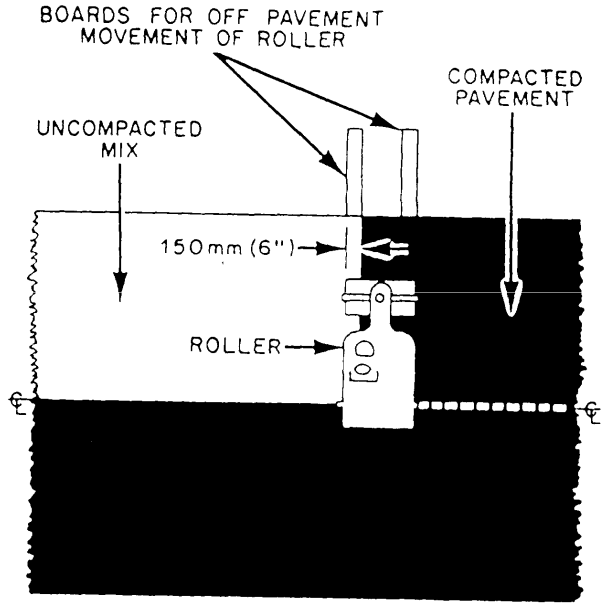


Figure 11-49.-Rolling a transverse joint.

covering 6 to 8 inches of fresh material until the entire width of a roll is on the new mix.

During transverse rolling, boards of proper thickness should be placed at the edge of the pavement to provide the roller a surface to drive on once it passes the edge of the hot bituminous mat. If boards are not used, the transverse rolling must stop 6 to 8 inches short of the outside edge in order to prevent damage to the edge. The outside edge then must be rolled out during longitudinal rolling.

Longitudinal Joints

Longitudinal joints should be rolled directly behind the paving operation, Only 4 to 6 inches of the roller width should ride on the newly placed mix (fig. 11-50). The rest of the roller should ride on the previously compacted side of the joint. With each subsequent pass, more and more of the roller width is placed on the mix until the entire width of the roller is on the newly placed mat.

When rolling a longitudinal joint with a vibratory roller, the roller drum extends only 4 to 6 inches on the previously compacted lane with the rest of the drum width riding on the newly placed mat. The roller continues to roll along this line until a thoroughly compacted, neat joint is obtained.

Longitudinal joints can be categorized as a hot or cold joint.

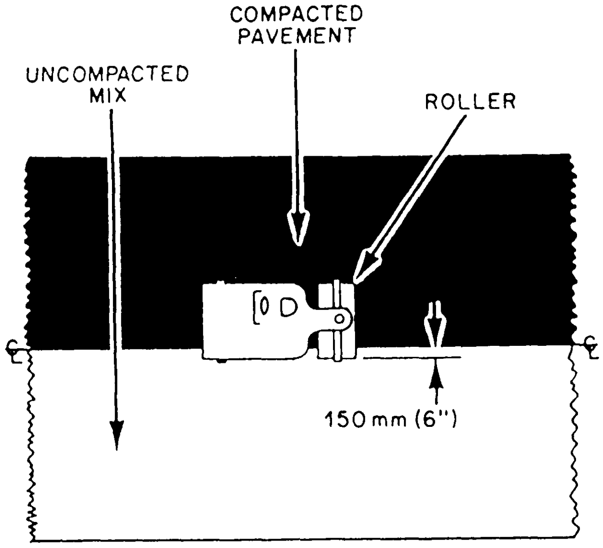


Figure 11-50.—Rolling a longitudinal joint.

HOT JOINTS.— A hot joint is a joint between two lanes of bituminous mix placed at approximately the same time by pavers working in echelon. This type of laydown produces the best longitudinal joint, because both lanes are at, or near, the same temperature when rolled. The material compacts into a single mass under the roller, resulting with little or no difference in density between the two lanes. When you are paving in echelon, the breakdown roller following the lead paver leaves a 3- to 6-inch unrolled edge that the second paver follows. The second paver and roller should stay as close as possible to the first paver to ensure a uniform density is obtained across the joint. The roller following the second paver compacts the hot joint on its first pass (fig. 11-51).

COLD JOINTS.— A cold joint is a joint between two lanes, one of which has cooled overnight or longer before the adjoining lane is placed. Because of the difference in temperature between the two lanes, there is a difference in density between the two sides of the joint. The longitudinal joint should be rolled directly behind the paver.

Breakdown Rolling

Breakdown rolling may be accomplished with static or vibratory steel-wheel rollers. Breakdown rolling should start on the low side of the hot bituminous mat, which is usually the outside of the lane being paved, and progress toward the high side. The reason for this is that hot bituminous mixtures tend to migrate towards the low side of the mat under the action of the roller. If rolling is started on the high side, this migration is much more pronounced than if the rolling progresses from the low side. When adjoining lanes are placed, the same rolling procedure should be followed, but only after compaction of the longitudinal joint.

A rolling pattern that provides the most uniform coverage of the lane being paved should be used. Rollers vary in width, and a single recommended pattern that applies to all rollers is impractical. For this reason, the best rolling pattern for each roller being used should be worked out and followed to obtain the most uniform compaction across the lane.

The rolling pattern not only includes the number of passes but also the location of the first pass, the sequence of succeeding passes, and the overlapping between passes. Rolling speed should not exceed 3 mph. In addition, sharp turns and quick starts or stops are to be avoided.

For thin lifts (a lift of less than 2 inches compacted thickness), a recommended rolling pattern for static

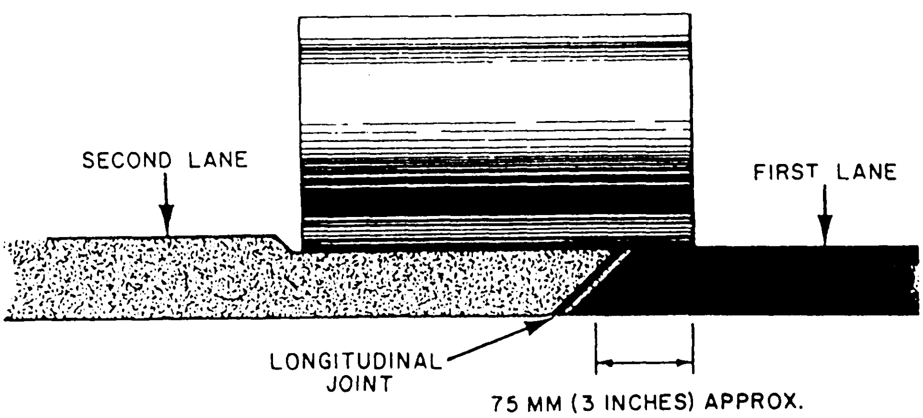


Figure 11-51.—Rolling a hot longitudinal joint.

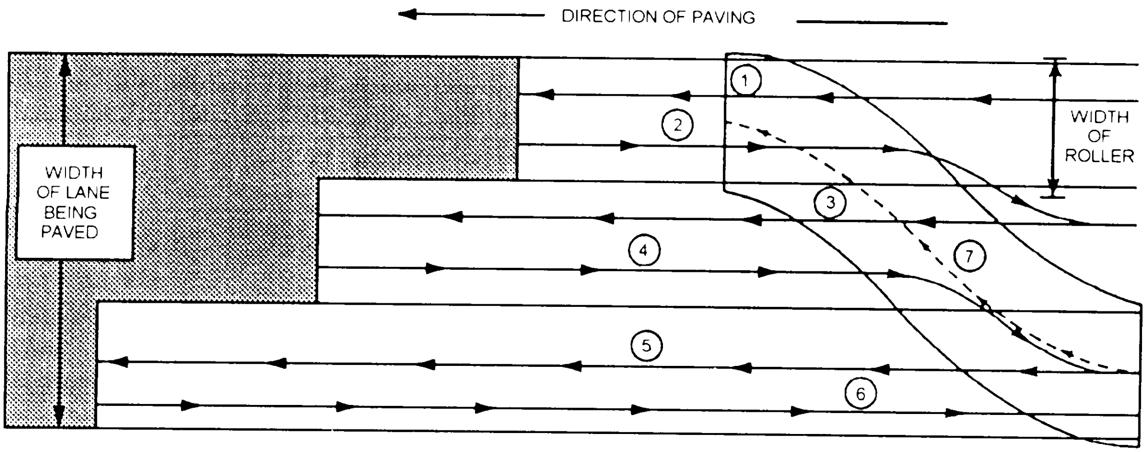


Figure 11-52.—Correct rolling pattern.

steel-tired rollers is shown in figure 11-52. The rolling operation should start from the edge of the hot mat on the low side with the roller moving forward as close behind the paver as possible. The second movement of the roller should be reversed in the same path until the roller has reached previously compacted material. At this point align the roller for pass number three, again staying as close as possible behind the paver. The fourth movement is a reversal of the third path and a repetition of the third operation. After the entire width of the hot mix has been rolled in this fashion, you should swing the roller back to the low side and repeat the process. With this pattern, on each forward pass the roller only needs to overlap the previous rolled area by 3 to 4 inches.

For thick lifts (a lift of 4 inches or more compacted thickness), the rolling process should start 12 to 15 inches from the lower unsupported edge and progress towards the center portion of the hot mix. The uncompacted edge provides initial confinement during the first pass, thus minimizing lateral movement of the hot mix. After the central portion of the hot mix has been rolled and compacted, the compacted portion of the hot mix will support the roller and allow the edge to be compacted without lateral movement.

When using steel-wheeled rollers, the operation should always progress with the drive wheel forward in the direction of travel. This is especially important in breakdown rolling. A primary reason that breakdown rolling should be done with the drive wheel in the direction of travel is that there is a more direct vertical load applied by this wheel than by the tiller wheel (fig. 11-53).

If the breakdown pass of the roller is made with the tiller wheel forward, the pushing force and the weight arc slightly ahead of the downward vertical force, causing material to push up in front of the wheel. The greater weight of the drive wheel produces the compaction, while the turning force tends to tuck the hot mix under the front of the wheel.

There are cxceptions to rolling with the drive wheel forward. They usually occur when superelevations are being constructed or if the grade on which the asphalt mix is being placed is excessive. The exception occurs when, due to these high grades, the drive wheel of the roller begins to chatter on the hot mat, causing displacement of the hot mix resulting with a very rough

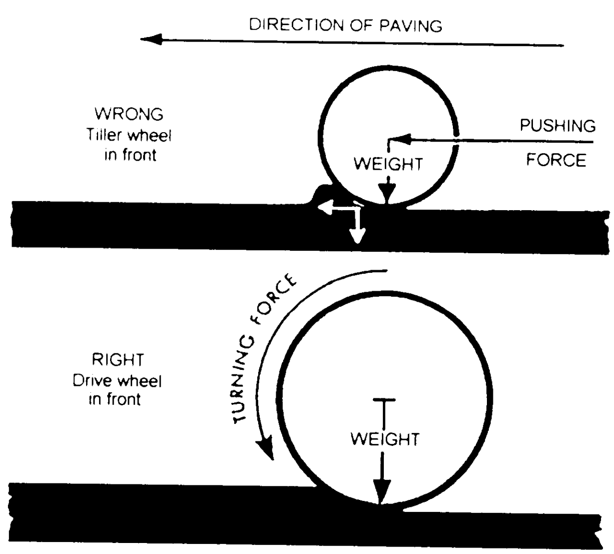


Figure 11-53.—Forces acting when tiller wheel or drive wheel is forward.

surface. In these cases, the roller must be turned around to allow the tiller wheel to compact the material partially so the drive wheel can then proceed over it.

Intermediate Rolling

Intermediate rolling should closely follow breakdown rolling, while the asphalt mix is still well above the minimum temperature of 185 degrees at which densification can be achieved. Pneumatic-tired or vibratory rollers may be used for intermediate rolling. Pneumatic-tired rollers have several advantages:

1. They provide a more uniform degree of compaction than steel-wheeled rollers.

2. They improve the seal near the surface by **kneading** the material closer together.

3. They orient the aggregate particles for greatest stability, as high ground pressure truck tires do after using the asphalt surface for some time.

Tire contact pressures should be as high as possible without causing displacement of the mix that cannot he remedied in the final rolling.

Pneumatic-tired rolling should be continuous after breakdown rolling until all of the hot mix has been thoroughly compacted. At least three coverages should be made.

NOTE: Turning of pneumatic-tired rollers on the hot mix should not be permitted unless it does not cause undue displacement.

Vibratory rollers (of proper static weight, vibration frequency, and amplitude) are used to provide required densities with fewer coverages than static-weight tandem or pneumatic-tired rollers (or combinations of the two).

Regardless of the type of roller used, the rolling pattern should be developed in the same manner as for breakdown rolling. This pattern should be continued until the desired compaction is obtained.

Finish Rolling

Finish rolling is done solely for the improvement of the surface. It should be accomplished with steel-wheel tandems, static-weight or vibratory, while the hot mat is still warm enough for removal of roller marks.

ROLLER SAFETY

Many of the safety precautions previously listed for graders, scrapers, and dozers also apply to roller operations. Additional safety precautions are as follows:

- Never perform roller operations alone. Always have a safety person in the area of the rolling operation.

-

machine can be kept under control at all times.

- Always wear a scat belt when rolling, as well as other required personal protective equipment, such as steel toe safety shoes and hard hats.

-

from a standing position.

- Use the safety handrails when mounting or dismounting a roller. Do not grab the transmission control levers, as this might cause the roller to make a sudden movement.

-

position besides neutral, this machine should be **hardcarded** and repaired before further usage.

- Use caution and make sure the area is clear of personnel, tools, and vehicles when performing forward and reverse rolling operations.

- A roller is easier to overturn than most equipment. Rolling on a side slope should always be done at right angles or diagonally, rather than parallel to the slope.

- Steer carefully when rolling a shoulder to avoid capsizing into the ditch, and never bring a roller near the edge of a cut.

- Use extreme care when loading steel-wheeled rollers on tractor-trailers during periods of inclement weather, The wet deck of the trailer can cause a steel-wheel roller to slip during loading and unloading operations.

APPENDIX I

GLOSSARY

AGGREGATE— Crushed rock or gravel, screened to sizes for use in road surfaces, concrete, or bituminous mixes.

ANGLING DOZER (Angledozer)—A bulldozer with a blade that can be pivoted on a vertical center pin so as to cast its load to either side.

APRON— The front gate of a scraper body.

ASPHALT— A dark brown to black cementitious material in which the predominating constituents are bitumens that occur in nature or are obtained in petroleum processing. Asphalt is a constituent in varying proportions of most crude petroleums.

ASPHALT CEMENT— A fluxed or unfluxed asphalt specially prepared as to quality and consistency for direct use in the manufacture of asphalt pavements.

ASPHALT CONCRETE— High-quality thoroughly controlled hot mixture of asphalt cement and well-graded, high-quality aggregate, thoroughly compacted into a uniform, dense mass.

ASPHALT LEVELING COURSE— A course (asphalt aggregate mixture) of variable thickness used to eliminate irregularities in the contour of an existing surface before a superimposed treatment or construction.

ASPHALT, MEDIUM-CURING (MC)— Cutback asphalt, composed of asphalt cement and a kerosene type of diluent of medium volatility.

ASPHALT, RAPID-CURING (RC)— Cutback asphalt, composed of asphalt cement and naphtha or gasoline type of diluent of high volatility.

ASPHALT, SLOW-CURING (SC)— Cutback asphalt, composed of asphalt cement and oils of low volatility.

AUGER— A rotating drill having a screw thread that carries cuttings away from the face.

AUXILIARY— A helper or standby engine or unit.

AXIS OF ROTATION— The vertical line around which the upper structure rotates.

AXLE, LIVE— A revolving horizontal shaft.

BACKFILL— (1) The material used in refilling a ditch or other excavation. (2) The process of such refilling.

BAIL BLOCK— Block attached to a dragline bucket, through which rope line is reeved. Also referred to as "PADLOCK."

BAIL (BUCKET)— A yoke or spreader, hinged to the sides of a dragline bucket, to which is attached a connecting sheave or chain for hoisting and dragging operations.

BALL JOINT— A connection, consisting of a ball and socket, that will allow a limited hinge movement in any direction.

BANK— Specifically, a mass of soil rising above a digging or trucking level. Generally, any soil that is to be dug from its natural position.

BANK GRAVEL— Gravel found in natural deposits, usually more or less intermixed with fine material, such as sand or clay, and combinations thereof; gravelly clay, gravelly sand, clayey gravel, and sandy gravel indicate the varying proportions of the materials in the mixture.

BASE COURSE— The layer of material immediately beneath the surface or intermediate course. It may be composed of crushed stone, crushed slag, crushed or uncrushed gravel and sand, or combinations of these materials. It also may be bound with asphalt.

BANK YARDS— Yards of soil or rock measured in its original position (before digging).

BEDROCK— Solid rock, as distinguished from boulders.

BENCH— A working level or step in a cut that is made in several layers.

BINDER— (1) Fines which hold gravel together when it is dry. (2) A deposit check that makes a contract valid.

BITUMEN— A class of black or dark-colored (solid, semisolid, or viscous) cementitious substance, natural or manufactured, composed principally of high molecular weight hydrocarbons, or which asphalts, tars, pitches, and asphaltites are typical.

BLASTING MAT– A heavy, flexible fabric of woven wire rope or chain, used to confine blasts.

BLEEDING OR FLUSHING– Is the upward movement of asphalt in an asphalt pavement, resulting in the formation of a film of asphalt on the surface. The most common cause is too much asphalt in one or more of the pavement courses, resulting from too rich a plant mix, an improperly constructed seal coat, too heavy a prime or tack coat, or solvent-carrying asphalt to the surface. Bleeding or flushing usually occurs in hot weather.

BLUE TOPS— Grade stakes with blue tops to indicate finish grade level, usually a 2-inch by 2-inch by 6-inch hub stake.

BM— Bench mark.

BODY— The load carrying part of a truck or scraper.

BOGIE AXLE— Two or more axles, mounted to a frame so as to distribute the load between the axles and permit vertical oscillation of the axles.

BOOM CHORD— A main corner member of a lattice type of boom.

BOOM, CRANE— A long, light boom, usually of lattice construction.

BOOM HOIST— Mechanism to control the elevation of the boom and to support it.

BOOM LACING– Structural truss members at angles to and supporting the boom chords of a lattice type of boom.

BOOM, LATTICE— A long, light boom fabricated of crisscrossed steel or aluminum angles or tubing.

BOOM LENGTH— Boom length is a straight line through the center line of the boom pivot pinto the center line of the boom point load hoist sheave pin, measured along the longitudinal axis of the boom.

BOWL— (1) The bucket or body of a carrying scraper. (2) Sometimes the moldboard or blade of a dozer.

BUCKET— A part of an excavator that digs, lifts, and carries dirt.

BULLDOZER— (1) A tractor equipped with a front pusher blade. (2) In a machine shop, a horizontal press.

CAPILLARY ATTRACTION— The tendency of water to move into fine spaces, as between soil particles, regardless of gravity.

CASING— A pipe lining for a drilled hole.

CAT— (1) A trademark designation for any machine made by the Caterpillar Tractor Company. (2) Widely used to indicate a crawler tractor of any make.

CAT HEAD— A capstan winch.

CATWALK— A pathway, usually of wood or metal, that gives access to parts of large machines.

CENTRIFUGAL FORCE— Outward force exerted by a body moving in a curved line. It is the force that tends to tip a car over in going around a curve.

C-FRAME— An angling dozer lift and push frame.

CHECK VALVE— Any device that will allow fluid or air to pass through it in only one direction.

CHOKER— A chain or cable so fastened that it tightens on its load as it is pulled.

CIRCLE REVERSE— The mechanism that changes the angle of a grader blade.

CLAM— A clamshell bucket.

CLAMSHELL— (1) A shovel bucket with two jaws that clamp together by their own weight when it is lifted by the closing line. (2) A crane equipped with a clamshell bucket.

CLAMSHELL BUCKET— Usually consists of two or more similar scoops hinged together and a head assembly connected to the outer corners by struts. When the head and hinge are pulled toward each other, the scoops are forced together to dig and hold material. Control is by a holding line reeved over a boom point sheave and attached to the head assembly to support the bucket in open position and usually by a closing line also reeved over a boom point sheave, ending in a force amplifying tackle or other means between the head assembly and scoop hinge to close the bucket.

CLAMSHELL BUCKET, HYDRAULIC— Usually consists of two or more scoops hinged to a head assembly housing the hydraulic cylinder or cylinders and the force amplifying linkage to open and close the scoops and to supply the digging force for the scoops. The bucket assembly is suspended from the boom by a rope. Because digging ability is largely dependent upon bucket weight, buckets are supplied in various weight classes which range from light, for easily dug stockpiled materials, to heavy, for excavating hardpan material and the like.

CLAMSHELL EQUIPMENT— Machines with clamshell attachments are used to load material from stockpiles, gondola cars, barges, and the like, or from virgin soil generally out of small-area holes, deep trenches, or from below water. Orange peel buckets, grapples, and similar rope suspended attachments are included in this classification.

CLOSING LINE— The rope reeved from the hoist drum to control closing of a rope-operated clamshell bucket.

COFFERDAM— A set of temporary walls, designed to keep soil and/or water from entering an excavation.

COLLAR— A sliding ring, mounted on a shaft so that it does not revolve with it, used in clutches and transmissions.

COMPACTION— The act of compressing a given volume. Insufficient compaction of the asphalt pavement courses may result in channeling on the pavement surface. Compaction is usually accomplished by rolling.

CONVEYOR BELT— An endless belt of rubber-covered fabric that transports material on its upper surface.

CORRUGATIONS (WASHBOARDING) AND SHOVING— Are types of pavement distortion. Corrugation is a form of plastic movement typified by ripples across the asphalt pavement surface. Shoving is a form of plastic movement, resulting in localized bulging of the pavement surface. These distortions usually occur at points where traffic starts and stops, on hills where vehicles brake on the downgrade, on sharp curves, or where vehicles hit a bump and bounce up and down. They occur in asphalt layers that lack stability. Lack of stability may be caused by a mixture that is too rich in asphalt, has too high a proportion of fine aggregate, has coarse or fine aggregate that is too round or too smooth, or has asphalt cement that is too soft. It may also be due to excessive moisture, contamination due to oil spillage, or lack of aeration when placing mixes using liquid asphalt.

CRACKS— Breaks in the surface of an asphalt pavement.

CRACKS, ALLIGATOR— Interconnected cracks forming a series of small blocks resembling an alligator's skin or chicken wire, caused by excessive deflection of the surface over unstable subgrade or lower courses of the pavement.

CRACKS, EDGE JOINT— Are the separation of the joints between the pavement and the shoulder, commonly caused by the alternate wetting and drying beneath the shoulder surface. Other causes are shoulder settlement, mix shrinkage, and trucks straddling the joint.

CRACKS, LANE JOINT— Longitudinal separation along the seam between two paving lanes caused by a weak scam between adjoining spreads in the courses of the pavement.

CRACKS, REFLECTION— Cracks in asphalt overlays that reflect the crack pattern in the pavement structure underneath. They are caused by vertical or horizontal movements in the pavement beneath the overlay, brought on by expansion and contraction with temperature or moisture changes.

CRACKS, SHRINKAGE— Are interconnected cracks forming a series of large blocks, usually with sharp corners or angles. Frequently they are caused by volume change in either the asphalt mix or in the base or subgrade.

CRACKS, SLIPPAGE— Are crescent-shaped cracks that are open in the direction of the thrust of wheels on the pavement surface. They result when there is a lack of good bond between the surface layer and the course beneath.

CRANE— A mobile machine, used for lifting and moving loads without the use of a bucket.

CRANE MATS— A device, used for supporting machines on soft ground, usually of timber construction.

CREEP— (1) Very slow travel of a machine or a part. (2) Unwanted turning of a shaft due to drag in a fluid coupling or other disconnect device.

CRUMBER— A blade that follows the wheel or ladder of a ditching machine to clean and shape the bottom.

CULVERT— A pipe or small bridge for drainage under a road or structure.

CURVE, VERTICAL— A change in gradient of the center line of a road or pipe.

CUTBACK ASPHALTS— Mixture of asphalt cement and a cutting agent. There are three main types.

DATUM— Any level surface taken as a plane of reference from which to measure elevations.

DEADHEADING— Traveling without a load, except when traveling from the dumping area to the loading point.

DENSITY— The ratio of the weight of a substance to its volume.

DIESELING— In a compressor, explosions of mixtures of air and lubricating oil in the compression chambers and/or other parts of the air system.

DOLLY— A unit consisting of a draw tongue, an axle with wheels, and a turntable platform to support a gooseneck trailer.

DOUBLE-CLUTCHING— Disengaging and engaging the clutch twice during a single-gear shift (change of gears) to synchronize gear speeds.

DOWNSTREAM FACE— The dry side of a dam.

DOZER— Abbreviation of bulldozer.

DRAFT— Resistance to movement of a towed load.

DRAGLINE— A crane with a dragline attachment, used to excavate material from below the grade on which the crane is sitting.

DRAWBAR— A fixed or hinged bar, extending to the rear of a tractor and used as a fastening for lines and towed machines or loads.

DRAWBAR HORSEPOWER— A tractor's flywheel horsepower minus friction and slippage losses in the drive mechanism and the tracks or tires.

DRAWBAR PULL— The pull that a tractor can exert on a load attached to the drawbar. Depends on power, weight, and traction.

DRILL COLLAR— Thick-walled drill pipe, used immediately above a rotary bit to provide extra weight.

DRILL, PERCUSSION— A drill that hammers and rotates a steel and bit. Sometimes limited to large blast hole drills of the percussion type.

DRILL PIPE— The sections of a rotary drilling string, connecting the kelly with the bit or collars.

DRIVE SPROCKET— A drive roller with teeth that engage matching recesses or pins (bushings) in the track assembly.

DROP HAMMER— A pile-driving hammer that is lifted by a cable and that obtains striking power by falling freely.

DRUM, SPUDDING— In a churn drill, the winch that controls the drilling line.

EJECTOR— A clean-out device, usually a sliding plate.

EMBANKMENT— A fill whose top is higher than the adjoining surface.

EROSION— Wear caused by moving water or wind.

FACE— (1) The more or less vertical surface of rock exposed by blasting or excavating or the cutting end of a drill hole. (2) An edge of rock used as a starting point in figuring drilling and blasting. (3) The width of a roll crusher.

FACTOR OF SAFETY— The ratio of the ultimate strength of the material to the allowable or working stress.

FAIRLEAD— A device which lines up cable so that it will wind smoothly onto a drum.

FEATHER— To blend the edge of new material into the old surface smoothly.

FIFTH WHEEL— The weight-bearing swivel connection between highway type of tractors and semitrailers.

FILL— An earth or broken rock structure or embankment. Soil or loose rock used to raise a grade. Soil that has no value except bulk.

FLOAT— In reference to a dozer blade, to rest by its own weight or to be held from digging by upward pressure of a load of dirt against its moldboard.

FOOT— In tamping rollers, one of a number of projections from a cylindrical drum.

FOOT-POUND— Unit of work equal to the force in pounds multiplied by the distance in feet through which it acts. When a 1-pound force is exerted through a 1-foot distance, 1 foot-pound of work is done.

FOUR BY FOUR (4 x 4)— A vehicle with four wheels or sets of wheels, all engine-driven.

FREE FALL— Lowering of the hook (with or without a load) without it being coupled to the power train with the lowering speed being controlled by a retarding device, such as a brake.

FRONT-END LOADER— A tractor loader with a bucket that operates entirely at the front end of the tractor.

FROST— Frozen soil.

FROST LINE— The greatest depth to which ground may be expected to freeze.

GANTRY— (1) An overhead structure that supports machines or operating parts. (2) An upward extension of the revolving frame of a crane that holds the boom line sheaves.

GEAR— A toothed wheel, cone, or bar.

GOOSENECK— An arched connection, usually between a tractor and a trailer.

GRADE— (1) Usually the elevation of a real or planned surface. (2) Also means surface slope.

GRADER— A machine with a centrally located blade that can be angled to cast to either side with an independent hoist control on each side.

GRADE STAKE— A stake indicating the amount of cut or fill required to bring the ground to a specified level.

GRAVEL— (1) Rock fragments from 2mm to 64 mm (.08 to 2.5 inches) in diameter. (2) A mixture of such gravel with sand, cobbles, boulders, and not over 15 percent fines.

GRIEF STEM— See "KELLY."

GRIZZLY— (1) A coarse screen used to remove oversize pieces from earth or blasted rock. (Maybe spelled "grizzlie.") (2) A gate or closure on a chute.

GROUND PRESSURE— The weight of a machine, divided by the area in square inches of the ground directly supporting it.

GROUSER— Projecting lug(s) attached to or integral with the ma chine track shoes to provide additional tract ion.

GRUBBING— Digging out roots.

HAND LEVEL— A sighting level that does not have a tripod, base, or telescope.

HARDPAN— (1) Hard, tight soil. (2) A hard layer that may form just below plow depth on cultivated land.

HAUL DISTANCE— (1) Is the distance measured along the center line or most direct practical route between the center of the mass of excavation and the center of mass of the fill as finally placed. (2) It is the distance the material is moved.

HOLDING LINE— The cable reeved from a hoist drum for holding a clamshell bucket or grapple suspended during dumping and lowering operations.

HOOK, PINTLE— A towing bracket, having a fixed lower part and a hinged upper one, which, when locked together, makes a round opening.

HOPPER— A storage bin or a funnel that is loaded from the top and discharges through a door or chute in the bottom.

HORSEPOWER— (1) A measurement of power that includes the factors of force and speed. (2) The force required to lift 33,000 pounds 1 foot in 1 minute.

HORSEPOWER, DRAWBAR— Horsepower available to move a tractor and its load after deducting losses in the power train.

HOLDING LINE— The hoist cable for a clamshell bucket.

IDLER— Large end roller of a track assembly at the opposite end from the drive sprocket; the roller is not power-driven.

INJECTOR— In a diesel engine, the unit that sprays fuel into the combustion chamber.

JACK— (1) A mechanical or hydraulic lifting device. (2) A hydraulic ram or cylinder.

JACKKNIFE— A tractor and trailer in such an angle that the tractor cannot move forward.

JAW— (1) In a clutch, one of a pair of toothed rings, the teeth of which face each other. (2) In a crusher, one of a pair of nearly flat faces separated by a wedge-shaped opening.

JIB BOOM— An extension piece, hinged to the upper end of a crane boom.

KELLY— A square or fluted pipe which is turned by a drill rotary table, while it is free to move up and down in the table. Also called a "GRIEF STEM."

LAGGINGS— Removable and interchangeable drum spool shells for changing the hoist drum diameter to provide variation in rope speeds and line pulls.

LAY— The direction of twist in wires and strands in wire rope.

LAY, REGULAR— A wire rope construction in which the direction of twist of the wires in the strands is opposite to that of the strands in the rope.

LEVEL— To make level or to cause to conform to a specified grade.

LIFT— A layer or course of paving material, applied to a base or a previous layer.

LIP— The cutting edge of a bucket. Applied chiefly to edges including tooth sockets.

LOAD BINDER— A lever that pulls two grab hooks together and holds them by locking over the center.

LOADER, FRONT-END— A tractor loader that both digs and dumps in front.

LOAM— A soft easily worked soil, containing sand, silt, and clay.

LOOSE YARDS— Measurement of soil or rock after it has been loosened by digging or blasting.

LOW BED— A machinery trailer with a low deck.

LUFFING— Operation of changing the boom angle in the vertical plane. See "BOOM HOIST."

LUG DOWN— To slow down an engine by increasing its load beyond its capacity.

MASS DIAGRAM— A plotting of cumulative cuts and fills, used for engineering computation of construction jobs.

MINERAL DUST— The portion of the fine aggregate passing the 0.075-mm (No. 200) sieve.

MINERAL FILLER— A finely divided mineral product, at least 70 percent or which will pass a 0.075-mm (No. 200) sieve. Pulverized limestone is the most commonly manufactured filler, although other stone dust, hydrated lime, portland cement, and certain natural deposits of finely divided mineral matter are also used.

MISFIRE— Failure of all or part of an explosive charge to go off.

MOLDBOARD— A curved surface of a plow, dozer blade, grader blade, or other dirt-moving implement that gives dirt moving over it a rotary, spiral, or twisting movement.

MUCK— Mud rich in humus.

OIL— Any fluid lubricant, but not water.

OPEN-GRADED ASPHALT FRICTION COURSE— A pavement surface course that consists of high-void, asphalt plant mix that permits rapid drainage of rainwater through the course and out the shoulder. The mixture is characterized by a large percentage of one-sized coarse aggregate. This course prevents tire hydroplaning and provides a skid-resistant pavement surface.

OPTIMUM— Best.

OSCILLATION— Independent movement through a limited range, usually on a hinge.

OUTRIGGER— An outward extension of a frame that is supported by a jack or block, used to increase stability.

OVERBURDEN— Soil or rock lying on top of a pay formation.

PAN— A carrying scraper.

PAWL— A tooth or set of teeth, designed to lock against a ratchet.

PENETRATION— The consistency of a bituminous material expressed as a distance in tenths of a millimeter (0.1mm) that a standard needle penetrates vertically a sample of the material under specified conditions of loading, time, and temperature.

PERCENT OF GRADE— Measurement of slope, expressed as the ratio of the change in vertical distance (rise) to the change in horizontal distance (run) multiplied by 100.

PETCOCK— A small drain valve.

PILE CAP— An adapter between the pile-driving unit and the upper end of the pile, used to center the pile under the pile-driving unit and to reduce damage to the upper end of the pile.

PIONEERING— The first working over of rough or overgrown areas.

PIONEER ROAD— A primitive, temporary road built along the route of a job to provide means for moving equipment and men.

POND— A small lake.

PORT— Left side of a ship or boat.

POTHOLE— A small steel-sided hole caused by traffic wear.

POWER EXTRACTOR— A unit hanging from the hoist line or block and attached to the upper end of the pile and containing within itself a member (ram) which is caused to reciprocate either by means of externally supplied air, steam, or hydraulic fluid under pressure, or by internal combustion within the unit. Upward pull from the hoisting machinery supplements the extraction forces.

POWER PLANT— The power plant (or plants) includes the prime power source (which may be an internal combustion engine or electric motor) and the power takeoff.

POWER TAKEOFF— A place in a transmission or engine to which a shaft can be so attached as to drive an outside mechanism. A power takeoff may be direct drive, friction clutch, fluid coupling, hydrodynamic torque converter, hydrostatic, or an electric generator type.

POWER TRAIN— All moving parts connecting an engine with the point or points where work is accomplished.

PRIME MOVER— A tractor or other vehicle used to pull other machines.

PROPELLER SHAFT— Usually a main drive shaft fitted with universal joints.

PSI or psi— Pressure in pounds per square inch.

PUMP, DIAPHRAGM— A pump that moves water by the reciprocating motion of a diaphragm in a chamber having inlet and outlet check valves.

PUSHER— A tractor that pushes a scraper to help it pick up a load.

RAKE BLADE— A dozer blade or attachment made of spaced tines.

RAKE, ROCK— A heavy-duty rake blade.

RANGE POLE— A pole marked in alternate red and white bonds, 1 foot high.

RED TOPS— Grade stakes with red tops to indicate finish subgrade level, usually a 2-inch by 2-inch by 6-inch hub stake.

REFUSAL— The depth beyond which a pile cannot be driven.

RIPRAP— Heavy stones placed at the edge of the water to protect the soil from waves or current.

RIPPER— A towed machine, equipped with teeth, used primarily for loosening hard soil and soft rock.

ROAD OIL— A heavy petroleum oil, usually one of the slow-curing (sc) grades.

ROCK— The hard, firm, and stable parts of earth's crust.

ROTARY TILLER— A machine that loosens and mixes soil and vegetation by means of a high-speed rotor equipped with tines.

RPM or rpm— Revolutions per minute.

RUBBLE DRAINS— French drains.

RULE OF THUMB— A statement or formula that is not exactly correct but is accurate enough for use in rough figuring.

SAND— A loose soil, composed of particles between 1/16 mm and 2 mm in diameter.

SCRAPER (Carrying scraper) (Pan)— A digging, hauling, and grading machine, having a cutting edge, a carrying bowl, a movable front wall (apron), and a dumping or ejecting mechanism.

SCREEN— (1) A mesh or bar surface, used for separating pieces or particles of different sizes. (2) A filter.

SEIZE— To bind wire rope with soft wire to prevent it from raveling when it is cut.

SEMITRAILER— A towed vehicle whose front rests on the towing unit.

SHEEPSFOOT— A tamping roller with feet expanded at their outer tips.

SHOE— (1) A ground plate, forming a link of a track or bolted to a track link. (2) A support for a bulldozer blade or other digging edge to prevent cutting down. (3) A clean-up device following the buckets of a ditching machine.

SIDECASTING— Piling spoil alongside the excavation from which it is taken.

SNATCH BLOCK— A pulley in a case that can be easily fastened to lines or objects by means of a hook, ring, or shackle.

SPILLWAY— An overflow channel for a pond or a terrace channel.

SPROCKET— A gear that meshes with a chain or a crawler track.

STOCKPILE— Material dug and piled for future use.

STONE— Rock.

SUPERCHARGER— A blower that increases the intake pressure of an engine.

SURGE BIN— A compartment for temporary storage.

SWELL (Growth)— Increase of bulk in soil or rock when it is dug or blasted.

SWING LOCK— A swing lock is a mechanical engagement device, not dependent on friction, to hold the upper structure in one or more fixed positions with respect to the undercarriage. When provided, it must be constructed to prevent unintentional engagement or disengagement.

SWING BRAKE (Dynamic)— A dynamic swing brake is a device to stop, hold, or retard the rotating motion of the upper structure with respect to the undercarriage.

SWITCHBACK— A hair-pin curve.

TAG LINE— A line from a crane boom to a clamshell bucket that holds the bucket from spinning out of position.

TAMP— Pound or press soil to compact it.

TERRACE— A ridge, a ridge and hollow, or a flat bench built along a ground contour.

TERRAIN— Ground surface.

TOE— The projection of the bottom of a face beyond the top.

TOOTH ADAPTER— Main part of bucket or dipper to which a removable tooth is fastened.

TOPOGRAPHIC MAP— A map, indicating surface elevation and slope.

TOPSOIL— The topmost layer of soil, usually refers to soil containing humus that is capable of supporting good plant growth.

TORQUE— The twisting force exerted by or on a shaft (without reference to the speed of the shaft).

TRACK— A crawler track.

TRACK CARRIER ROLLERS— Rolling elements in/on a track frame that support and guide the upper track shoes or chain.

TRACK SHOES— The members of the track assembly that distribute the load to the supporting surface.

TRACTION— The total amount of driving push of a vehicle on a given surface.

TRENCH— A ditch.

TRUNNION (Walking beam or bar)— (1) An oscillating bar that allows changes in angle between a unit fastened to its center and another attached to both ends. (2) A heavy horizontal hinge.

UNDERCARRIAGE— The undercarriage is an assembly that supports the upper structure of the crane. It consists of an undercarriage frame, a swing bearing, or hook and load rollers, travel mechanism, and steering mechanism. The undercarriage may be either a crawler or wheeled type.

VISCOSITY— The resistance of a fluid to flow. A liquid with a high viscosity rating will resist flow more readily than will a liquid with a low viscosity. The Society of Automotive Engineers (S.A.E.) has developed a series of viscosity numbers for indicating viscosities of lubricating oils.

VOIDS— Empty spaces in a compacted mix, surrounded by asphalt-coated particles.

VOLTS— The electromotive force that will cause a current of 1 ampere to flow through a resistance of 1 ohm.

WATERLOGGED— Saturated with water. If conditions are too wet, you will be unable to work construction equipment.

WATERSHED— Area that drains into or pasta point.

WATER TABLE— The surface of underground, gravity-controlled water.

WHEEL AND AXLE ARRANGEMENT— The wheeled undercarriages.

WINCH— A drum that can be rotated so as to exert a strong pull while winding in a line.

WINDROW— A ridge of loose dirt.

WING WALL— A wall that guides a stream into a bridge opening or culvert barrel.

WORKING CYCLE— A complete set of operations. In an excavator, it usually includes loading, moving, dumping, and returning to the loading point.