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ROAD AND LANDING CRITERIA FOR MOBILE-CRANE YARDING SYSTEMS

by

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ABSTRACT

Rising logging costs and increased environmental concern have been instrumental in bringing about the trend to mobile-crane, grapple yarding. This system is designed around the three-line running skyline and is characterized by low manpower requirements, increased safety of personnel, reduced average yarding distance, separate loading operation, and decreased soil disturbance. Log size is the most important variable affecting costs.

Roads should be located to take advantage of the yarder's mobility to reduce average yarding distance, must have adequate width for yarder operation independent of the loader, and should provide for uphill and downhill yarding. Landing areas should be such that logs will not roll or slide and the combined road and landing should provide sufficient room for the loading and trucking operations.

The usual types of landings are those continuous and adjacent to the road, split landings, and terminal landings. The continuous landing is the most common and least expensive, and the terminal landing is the least desirable.

Keywords: Logging, grapple yarding, cranes.

INTRODUCTION

Today's public is demanding that timber harvesting be conducted with minimal environmental impact; at the same time, the logging industry is faced with rising costs. These trends have prompted increased use of the mobile-crane, grapple-yarding system.

Since the early 1960's, mobile-crane, grapple-yarding systems have intrigued the logging industry. Much has been said and written about the peculiarities of the system, the equipment, and the increased production per man. Little has been said about the road and landing requirements.

The purpose of this note is to discuss the characteristics of the mobile-crane, grapple-yarding system and to present the major criteria for making road and landing decisions for operating the system. This information should be useful for those engaged in logging planning and layout, and those considering a mobile-crane, grapple-yarding system.

DESCRIPTION OF THE YARDING SYSTEM

The most common and most successful grapple-yarding system is designed around the three-line running skyline[1/][2/] and tracked or wheeled undercarriage for mobility, as shown in figure 1.

The yarder used with a three-line running skyline must provide a means for tensioning the receding line during yarding; i.e., the haul-back while inhauling, or the main and operating lines while outhauling. Since large amounts of horsepower are involved in tensioning the lines, some mechanism is usually provided to transfer all or a portion of this power to the driven drum. This mechanism is usually referred to as an interlock.

The necessity to exchange horsepower between drums of varying effective diameters and line-speeds complicates the design of the interlock. This accounts for the sophisticated interlock mechanisms that are an important element of modern running skyline yarders.

The operating principle of the grapple system is as follows:

1. The grapple is opened to release the log at the landing by

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1/ Ward W. Carson, Donald Studier, and Hilton H. Lysons. Running skyline design with a desk-top computer/plotter. Portland, Oreg., Pac. Northwest Forest & Range Exp. Stn., USDA Forest Serv. Res. Note PNW-153, 21 p., illus., 1971.

2/ Charles N. Mann. Mechanics of running skylines. Portland, Oreg., Pac. Northwest Forest & Range Exp. Stn., USDA Forest Serv. Res. Pap. PNW-75, 11 p., illus., 1969.

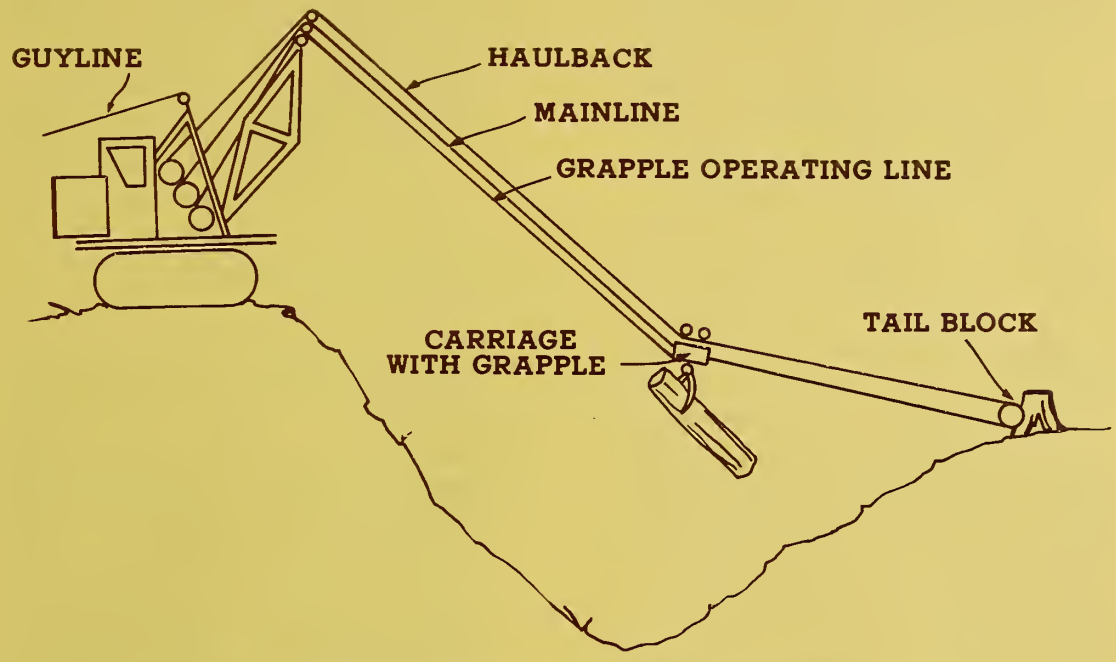

Figure 1.—Mobile-crane grapple-yarding system.

tightening the grapple operating line.

2. The grapple is outhauled by taking up on the haulback line and receding on the main and grapple operating lines.

3. The haulback line is slacked to place the grapple over the log, and the grapple operating line is slacked to close the grapple.

4. The log is yarded to the landing by hauling in on the main and grapple operating lines, while tension is maintained in the haulback line with the interlock. The swinging boom facilitates decking the yarded logs near the road.

This system can also be used with a slack pulling carriage, tagline, and chokers, where the operating line and main line are used to feed and retrieve tagline slack. However, this note will limit discussion to the grapple system.

With the grapple system, the

tail block either is fixed to a tree or stump or is rigged to a crawler tractor to give added mobility for changing the yarding road.

CHARACTERISTICS OF MOBILE-CRANE GRAPPLE YARDING

The major characteristics of mobile-crane yarding systems are:

1. Manpower requirements decreased. Average manpower requirements are two to three men, contrasted with five to seven for a high-lead yarding side. Most operations require only a yarder engineer and spotter; however, a third man is sometimes used for simultaneous rigging layout if a mobile tail block is not used.

2. Loading separated from yarding. The mobility of the yarding crane allows continuous decking of logs along the road. It is generally not necessary to work a loader with the yarder. This separates the loading operation from the yarding operation and facilitates continuous high efficiency trucking after sufficient logs are available.

3. Production increased. Log production per man is high. Average production per yarder varies between 170 and 210 logs per 8-hour shift. It is important to note that this system yards one log at a time, making log size the most important cost factor.

4. Chokers eliminated. Use of the grapple eliminates the choker setter, the chaser, and the problems associated with broken chokers.

5. Delay in setup and moving minimized. The mobility of the yarding crane and tail block makes road changes possible in a matter of minutes. The simple guyline system and outriggers on some machines reduce the delay of rigup.

6. Average yarding distances reduced. Yarding in parallel roads and moving the yarder around the tail block reduces average yarding distances.

7. Night operation practical. The elimination of choker setters and chasers and separate loading operations, plus the ease of grapple operation, allows night operation. Many operators double shift by illuminating the work area. Double shifts allow faster depreciation of equipment and increase efficiency of the loading operation since, under normal conditions, two yarding shifts can produce enough logs for one loading shift.

8. Snow operations possible. Operating in snow is possible since the grapple can penetrate the snow, and choker setters and chasers are not required. The only requirement is that the spotter be able to see the grapple and the log. He then spots the grapple by means of radio communication with the yarder operator.

9. Soil disturbance lessened. Soil disturbance is reduced, as with any skyline system, because of the lift provided the front end of the log. This eliminates or reduces damage caused by erosion and resulting stream siltation.

10. Safety increased. Safety is greatly enhanced because of the

reduced exposure of men to hazardous conditions. Increased safety is one of the greatest advantages of grapple yarding.

11. Grapple yarding is suitable only for clearcutting or partial cutting by means of clearcut strips.

ROAD CONSIDERATIONS

As a minimum, the roads must provide the load capacity and necessary dimensions to allow efficient yarder operation, loader operation, and support hauling. Drainage structures, such as bridges and culverts, must be designed or strengthened to support the weight of the larger mobile cranes.

With cable-yarding systems, the limiting factors for road location are yarding distance and topography. With mobile cranes, yarding distance is limited by topography (and its effect on deflection of the skyline) and yarder size. In general, yarding distance with present mobile-crane systems is under 1,000 feet slope distance.

Mobile-crane yarding systems have the capability to yard uphill or downhill. There are fewer hangups and less soil disturbance during downhill yarding because of the lift provided the front end of the log. The only requirements are that the grapple be placed over the log and that the skyline achieve sufficient deflection to support the grapple.

Mobile-crane systems provide two advantages in reducing average yarding distance. First, in yarding perpendicularly to the road with a continuous roadside landing, the average yarding distance is one-half the effective yarding distance (fig. 2).

With conventional systems, yarding to a fixed landing in a rectangular setting, the average yarding distance is always greater than 1/2 a as shown in figure 3.[3/]

3/ U. S. Department of the Interior. Logging, transportation, and contractual costs, schedule 16, table 1. Portland, Oreg., Bur. Land Manage., Serv. Center, 1970.

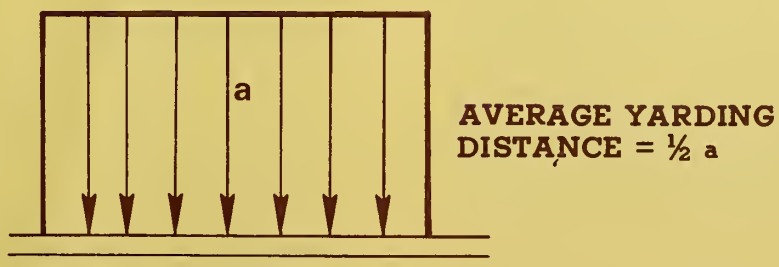

Figure 2.—Rectangular setting yarded perpendicularly to road.

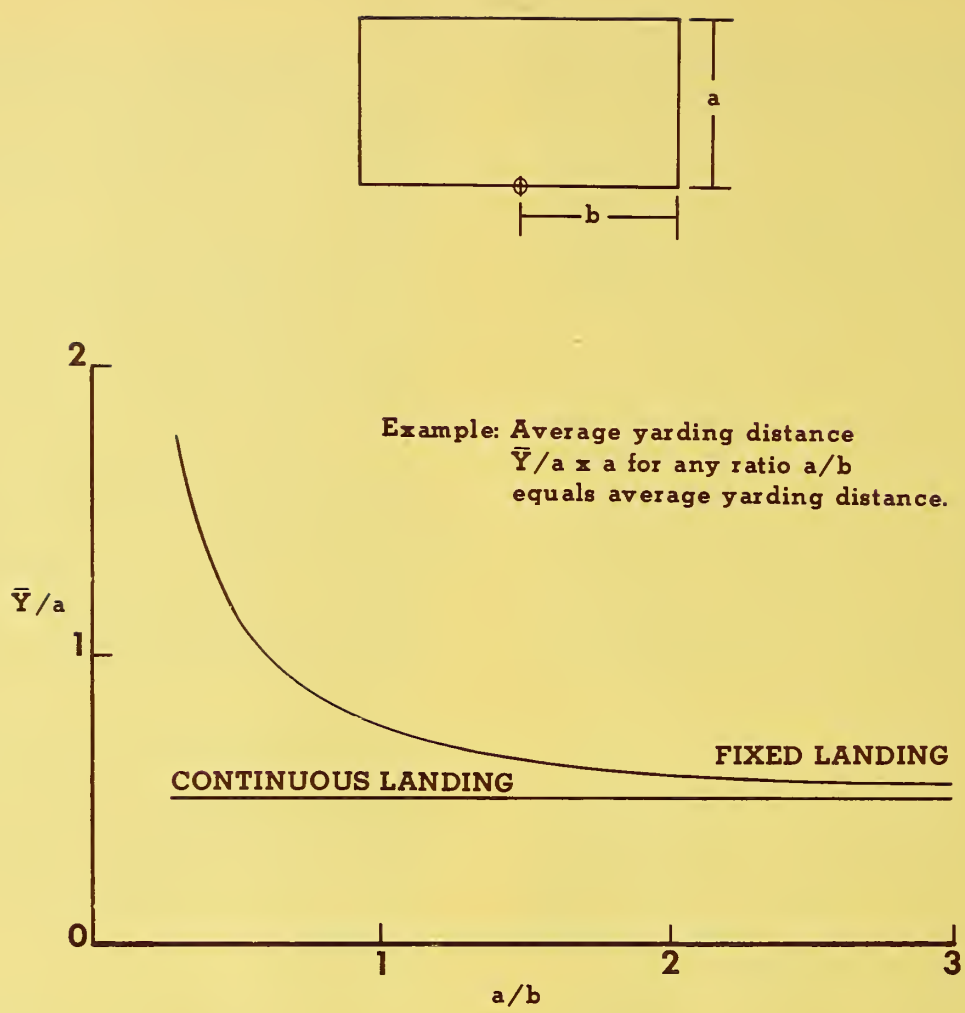

Figure 3.—Rectangular setting yarded to a fixed landing.

Second, the mobile crane's ability to move around a fixed tail block provides one-half the average yarding distance of high-lead, where the tail block is moved around the yarder, as shown in figure 4.

These characteristics point to the following road location considerations when planning for mobile-crane grapple yarding:

1. Take advantage of the yarder's ability to reduce average yarding distances by utilizing its mobility.
2. Provide adequate road dimensions for yarder operation independent of loader.
3. Take advantage of the capability to yard uphill and downhill.

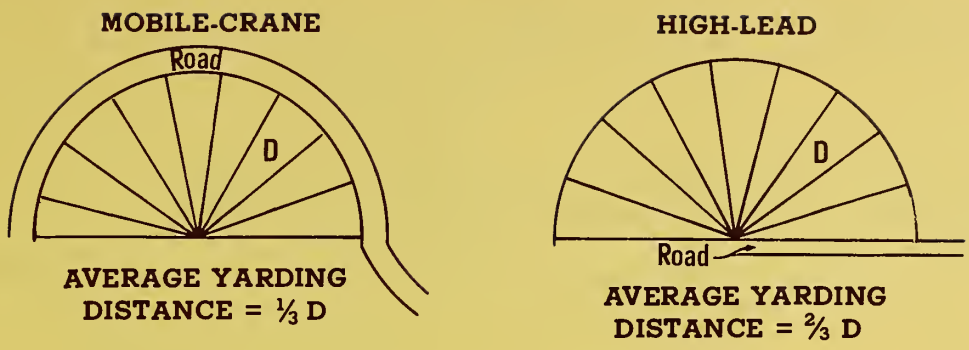

Figure 4.—Average yarding distance diagrams.

ROAD AND SETTING EXAMPLES

Figures 5 and 6 illustrate the plan and profile of a harvest unit where the logs are yarded downhill on parallel roads and yarded uphill on roads with a fixed tail block. The logs are decked along the road, both uphill and downhill, in a continuous landing. The harvest units can be irregularly shaped and still afford minimal average yarding distance.

Care must be taken placing the tail block so that the outer yarding limit is as close to the block as possible. For example, placing the block back on a bench could create a ground lead condition and difficulty in placement of the grapple. This should be kept in mind on benches and near the crest of ridges, as shown in figure 7. Figures 8 and 9 illustrate the plan and profile of a harvest unit that crosses an intermittent stream drainage, with both uphill and downhill yarding. This type of setting allows the deflection necessary for the skyline (fig. 10).

Mobile-crane grapple yarding is one of the most effective ways to yard logs across a drainage. Logs can be lifted over the water course with little, if any, disturbance to the stream or streambanks.

Figure 11 illustrates the location of a road for yarding timber around an intermittent stream drainage. Cutting unit layout of this type allows an irregularly shaped setting and provides the advantage of reduced average yarding distances. In this illustration, all yarding is uphill.

If all timber is to be removed, the same tail block near the intermittent stream could be used for yarding the opposite side of the draw.

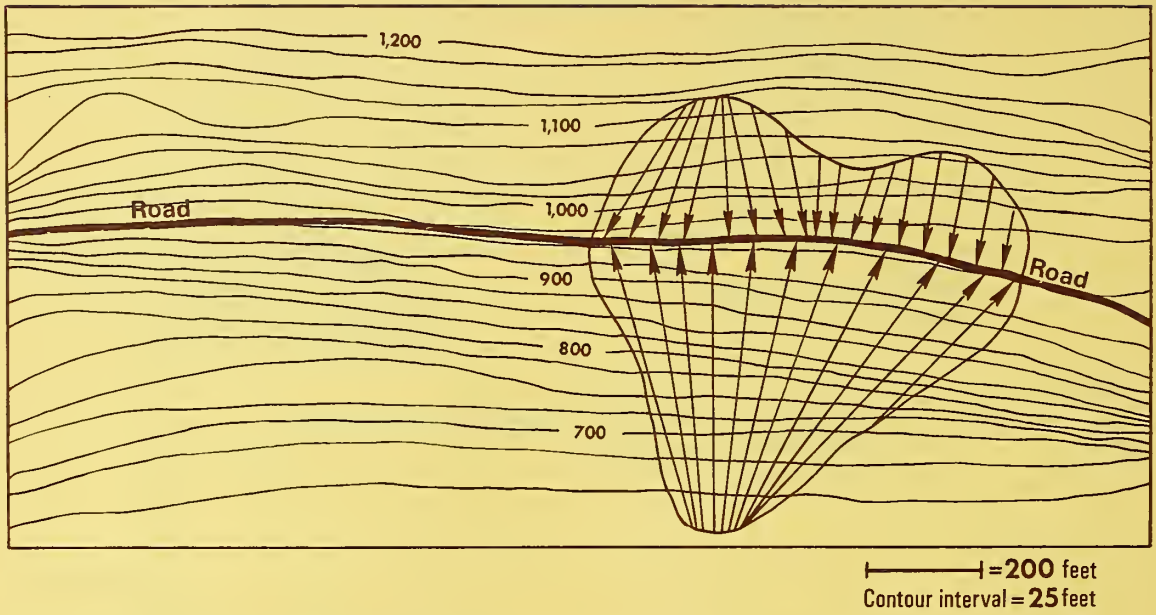

Figure 5.—Uphill and downhill yarding perpendicularly to road on a uniform slope.

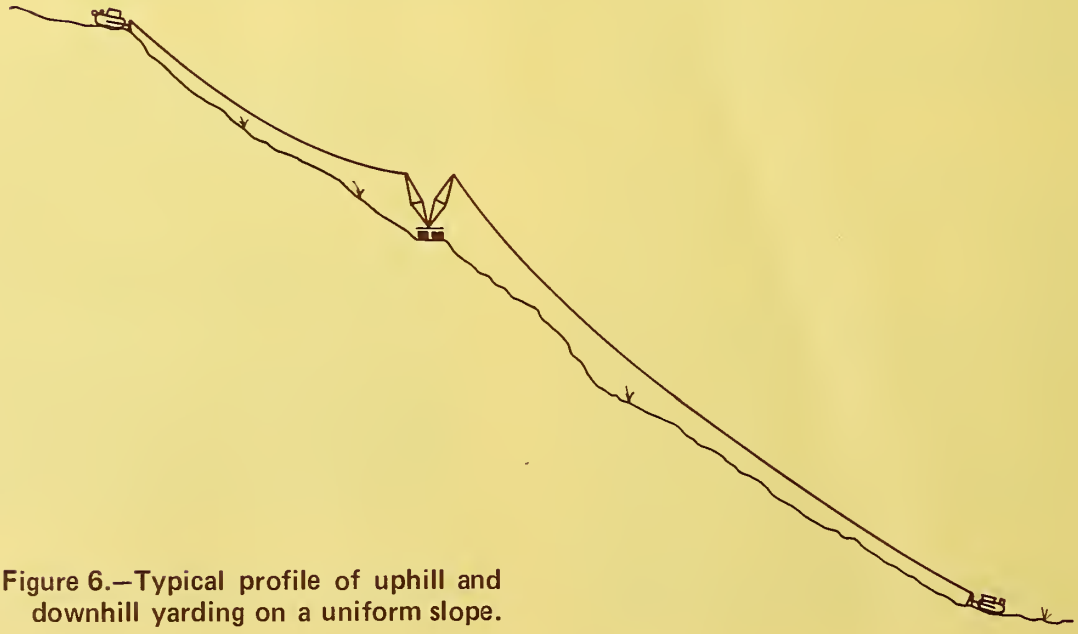

Figure 6.—Typical profile of uphill and downhill yarding on a uniform slope.

Figure 7.—Ground lead condition on crest of ridge.

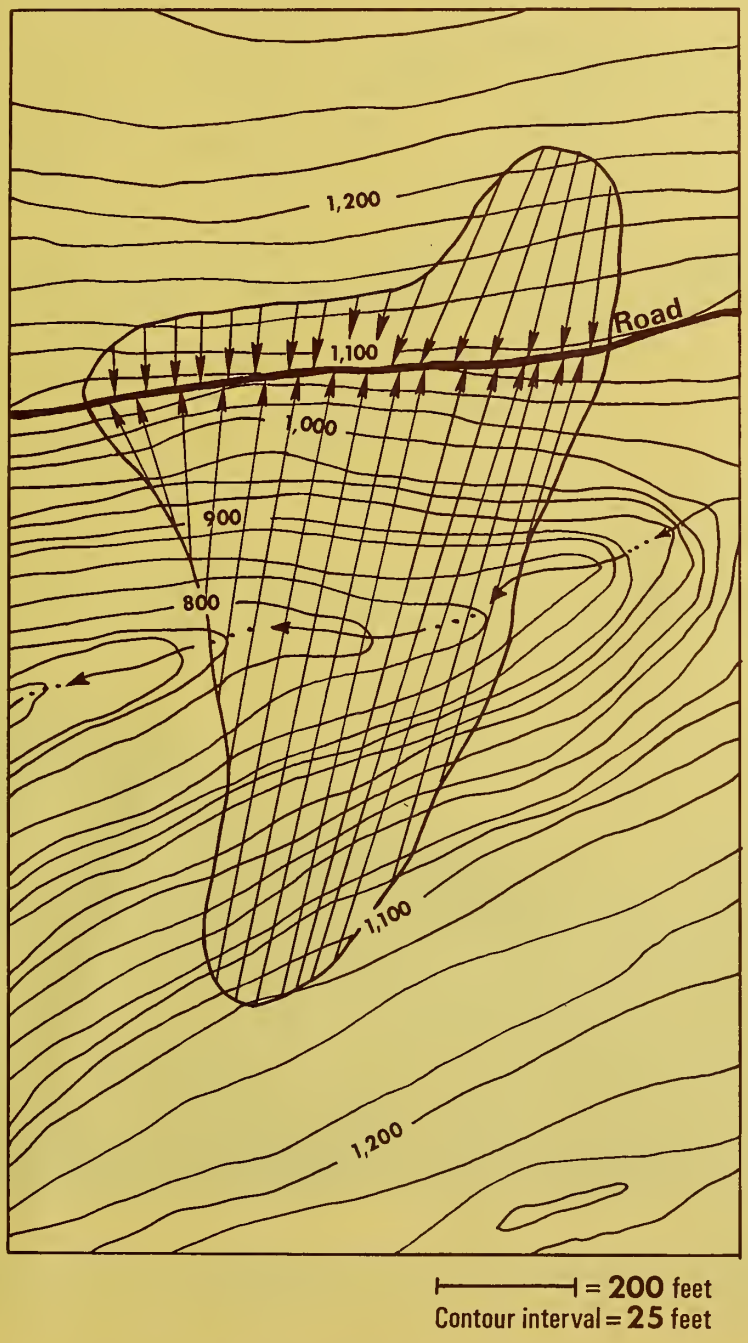

Figure 8.—Uphill and downhill yarding of U-shaped drainage.

Figure 9.—Typical profile of downhill and uphill yarding across drainage.

Figure 10.—Yarding across an intermittent stream drainage with the mobile tail block at a higher elevation than the yarder. This type of yarding profile provides optimum deflection and distance.

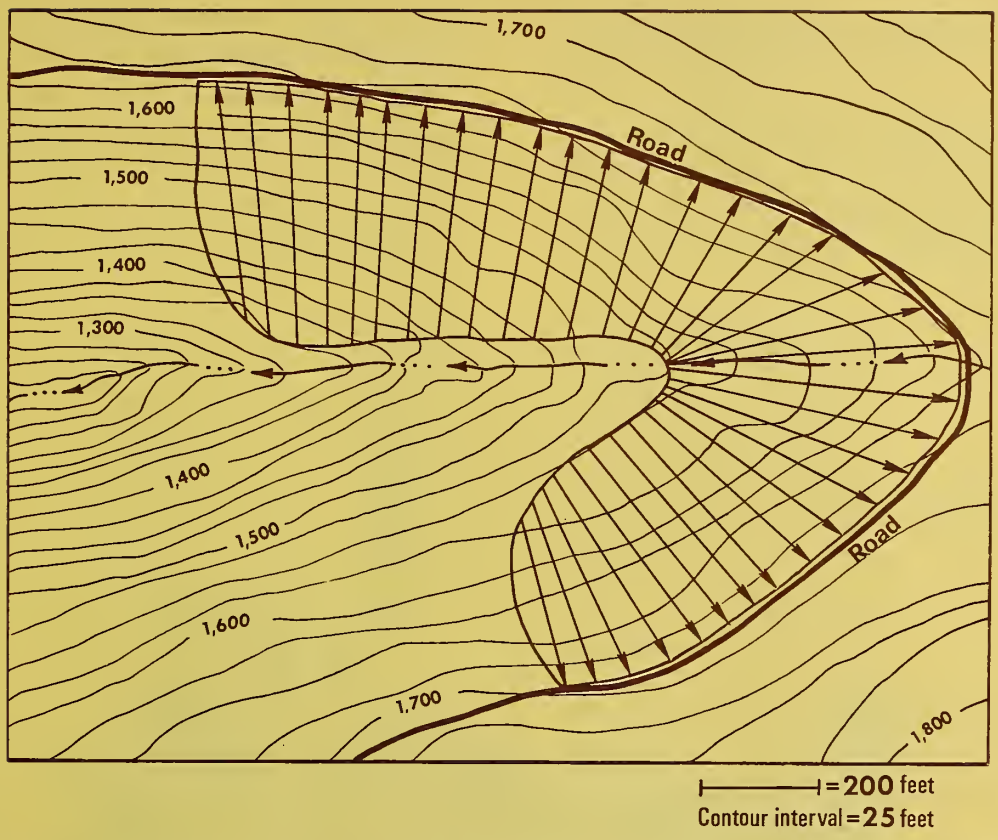

Figure 11.—Road location for yarding the head of an intermittent stream drainage.

LANDING CONSIDERATIONS

In mobile-crane grapple yarding, the loading can be separated from the yarding because the need for concentrated landings is eliminated. This is more efficient since the loading operation is approximately twice as fast as the yarding operation, and loading and hauling can be done in a continuous operation when there are sufficient logs stockpiled. Landings should complement this advantage.

There are two basic criteria for mobile-crane grapple-yarded landings. First, the slope of the ground should be such that the decked logs will not roll or slide after being released from the grapple. If the natural ground does not provide this, then the decking area must be modified by split landings or widened roadbeds. Second, the road and landing combination must provide sufficient swing room for the loader and clearance for the trucks. In steep terrain where the side slopes may be excessive, the major problem is the angle of the cut slope.

In mobile-crane yarding there are three types of landings:

a. Continuous landing adjacent to the roadway. This is the usual landing situation, and in level to moderately steep terrain there are no additional construction costs. The requirements are that the slope hold the logs and that there is room for efficient loader operation. Figure 12 shows a yarder decking beside the road on a widened subgrade. Figure 13 shows the resulting continuous landing adjacent to the roadway.

Figure 12.—Landing adjacent to road consisting of widened subgrade.

Figure 13.—Continuous landing adjacent to roadway.

b. Split landing. This type of landing requires additional construction costs. In the usual case, a separate yarder "road" is constructed at a level higher than the landing "road," as in figure 14. The yarder road must be able to support the weight of the yarder, and the loader road must be able to support the loader and trucks. Either can be temporary construction and "put to bed" after the harvest unit is complete. This type of landing is best suited to steep terrain where simple widening of the subgrade results in excessive road cuts and fills or wastage of soil materials on the downslope side of the landing.

c. Terminal landing. Terminal landings typically occur at the end of a road where the yarder location is fixed and a continuous landing is no longer possible. A terminal landing is necessary where yarding occurs in a radius around a road terminus in a manner typical of high-lead. In this case, the advantage of yarder mobility is lost.

Terminal landings require loading and hauling during yarding operations because logs accumulate at the concentrated landing. This in turn requires construction of a larger landing or a skidding tractor to keep the landing clear. The following considerations are important for a terminal landing:

1. Landing must be large enough that the yarder output is not restricted and log decks are not piled high.

2. Landing should be well drained.

3. Landing must be large enough to provide space for the yarder, clear of trucks and loader, and provide good visibility for the yarder operator.

The terminal landing is obviously the least desirable of the landings for mobile-crane grapple yarding.

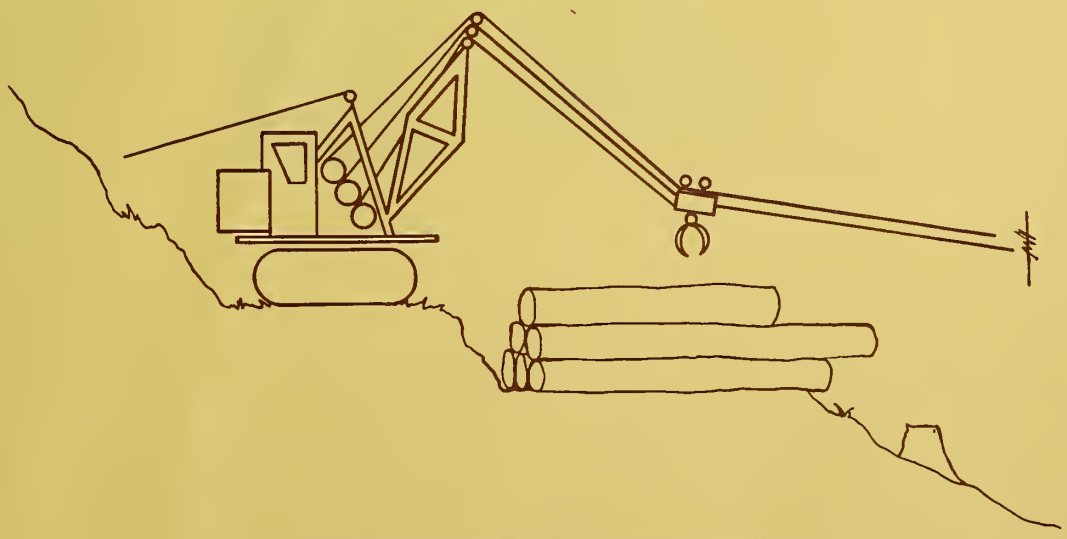

Figure 14.—Illustration of a split landing.

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