Timber Tech Tips

United States Department of Agriculture
Forest Service
Technology & Development Program
June 1994
2400 9424 1305—SDTDC

Monocable Zigzag Yarding System

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INTRODUCTION

The monocable zigzag yarding system has been used in many countries, particularly Japan, since its development in 1947 by Swiss engineer, Lasso Albert Schule. Since 1985 the system has been applied in a variety of operations in the United States. This Tech Tip is intended to provide a basic understanding of the system and its operation so potential users can determine its applicability to a particular task.

The monocable zigzag system is best suited to collecting small pieces (normally less than 120 pounds and not longer than 10 feet) from thinning or to manage fuel loading. In contrast with other light-wire cable systems, operation of the zigzag is nearly terrain-independent; uphill, downhill, and fully-suspended yarding across drainages are often found on the same setting. Its relatively low acquisition cost compared to other cable systems and its labor-intensive nature favor use by small contractors or family operations.

Recent applications have included precommercial thinnings for pulp-grade wood chips, firewood, and removal of posts and short poles. The system has also been employed to move logging debris to roadside and to collect Christmas trees in plantations too wet or steep for conventional wheeled tractors.

SYSTEM DESCRIPTION

The monocable zigzag yarding system is composed of four major components: the capstan winch, the blocks, the monocable (wire rope), and chokers (slings).

The Capstan Winch

There are a number of manufacturers of small engine-driven winches that can be used with a monocable system. The general requirements include:

1. The engine should be 4-cycle gas or diesel with 8 to 16 horsepower.
2. The gear train needs sufficient reduction to provide line speeds of 40 to 60 feet per minute, with some variation available by throttle adjustment. Line speed only needs to be fast enough to move the previous log out of the way for tying on the next one. Speeds in excess of these can be a safety hazard when tying chokers to the line. A transmission is considered optional but a means of engaging the gear train is essential. To avoid stalling the engine during a hang-up, a torque limiting device must be included to limit the torque transmitted by the engine to less than 80 percent.
3. The minimum diameter of the capstan should be 20 times the diameter of the wire rope. (See figures 1 and 2 for two different views of capstan winches). Larger capstan diameters reduce cable wear. To avoid excessive wear and to prevent excessive chafing of the oncoming rope against previous wraps, it is desirable to keep the fleet angle to one and one-half degrees.
4. The winch needs to be transportable. In many cases, winches have been mounted on trailers with provisions for anchoring the winch during operation.

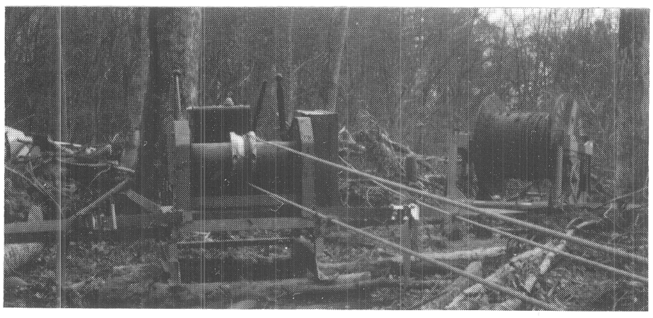

Figure 1.—Capstan winch installation.

Figure 2.—Close up of winch with capstan.

5. A powered storage drum which holds 3000 to 5000 feet of wire rope is convenient for recovering and storing the monocable.

Blocks

The sheave on a zigzag block is open on one side and equipped with "teeth" which serve to hold the monocable in the block while allowing the hanging chokers or slings to pass around the block. (See figure 3.) The gear (double) block or bow block are used when the monocable makes an interior angle greater than 150°. Snatch blocks are used as "sucker-down" blocks to pull the monocable closer to the ground within easy reach of the workers. The cutting block can be a snatch block with a bar and clamp for holding a blade for cutting the twine. All blocks should be sized for the line being used and contain a bushing/bearing that can be lubricated if not self-lubricating. The number of blocks needed varies for each setup. However, as a general rule, one zigzag block per 75 feet of line is recommended. The following quantity is sufficient for a 2500-foot layout:

Figure 3.—Open-end block with "teeth."

Table 1.—*2500-foot layout requirements.*

Type	Quantity
zigzag blocks	30
zigzag gear blocks	2
snatch blocks	2
cutting blocks	2 (changeable knives)

The Monocable

Use of wire rope diameters ranging from 1/4 to 1/2 inches have been reported in various trials. Between 3000 and 5000 feet should be available at most sites. In addition to the primary length of cable, additional cable lengths should be available to increase the length of the monocable to allow for winch positioning and tensioning. One user recommends additional lengths of 200, 80, and 40 feet with spliced eyes at each end.

Cable grips, which clamp onto the cable, are useful for pulling the cable around the setting during the rigging process.

Chokers (slings)

Various materials, such as sisal and plastic baling twine, nylon twine, and wire rope have been used for chokers. Twine chokers should be precut and pretied with loops at one end. (See figure 4.)

Figure 4.—Tying pole to cable with twine.

The weight of the load is not a problem for these light chokers because the twine can be doubled or tripled. Baling twine is readily available from local farm suppliers. Plastic or nylon can be used to contain pulp-quality chips.

TYPICAL OPERATIONAL CHARACTERISTICS

Layout of the monocable system involves selecting, flagging, and limbing all of the block trees and measuring the cableway distance. (See figure 5.) The cableway distance is matched with the cable length with an allowance for yarder positioning and tensioning of the monocable. Joining the cable ends may be done by making a long or short splice, which is very time consuming. Another option is a Chinese finger puzzle which slips over each end of the cable gripping it tightly as the tension in the cable increases.

Once the ends of the cable have been joined, the system must be tensioned. If a little slack is left in the cable, the yarder can be moved until the cable is pulled up to its operating tension. However, if there is too much slack and not enough room to reposition the yarder, a system of blocks can be used to take a bight in the line and tension the system.

Trees for hanging blocks (either guyed or not guyed) should be strong enough to support the cable and payload. They should be located so that logs are one-end or fully suspended during travel, especially over critical areas such as slope breaks, fragile soils, or streams. The open-sided blocks are hung with tree-protecting straps about six feet above the ground. If the cable is too high for the workers to reach to attach the chokers, a snatch block ("sucker-down block") may be installed to pull the line closer to the ground.

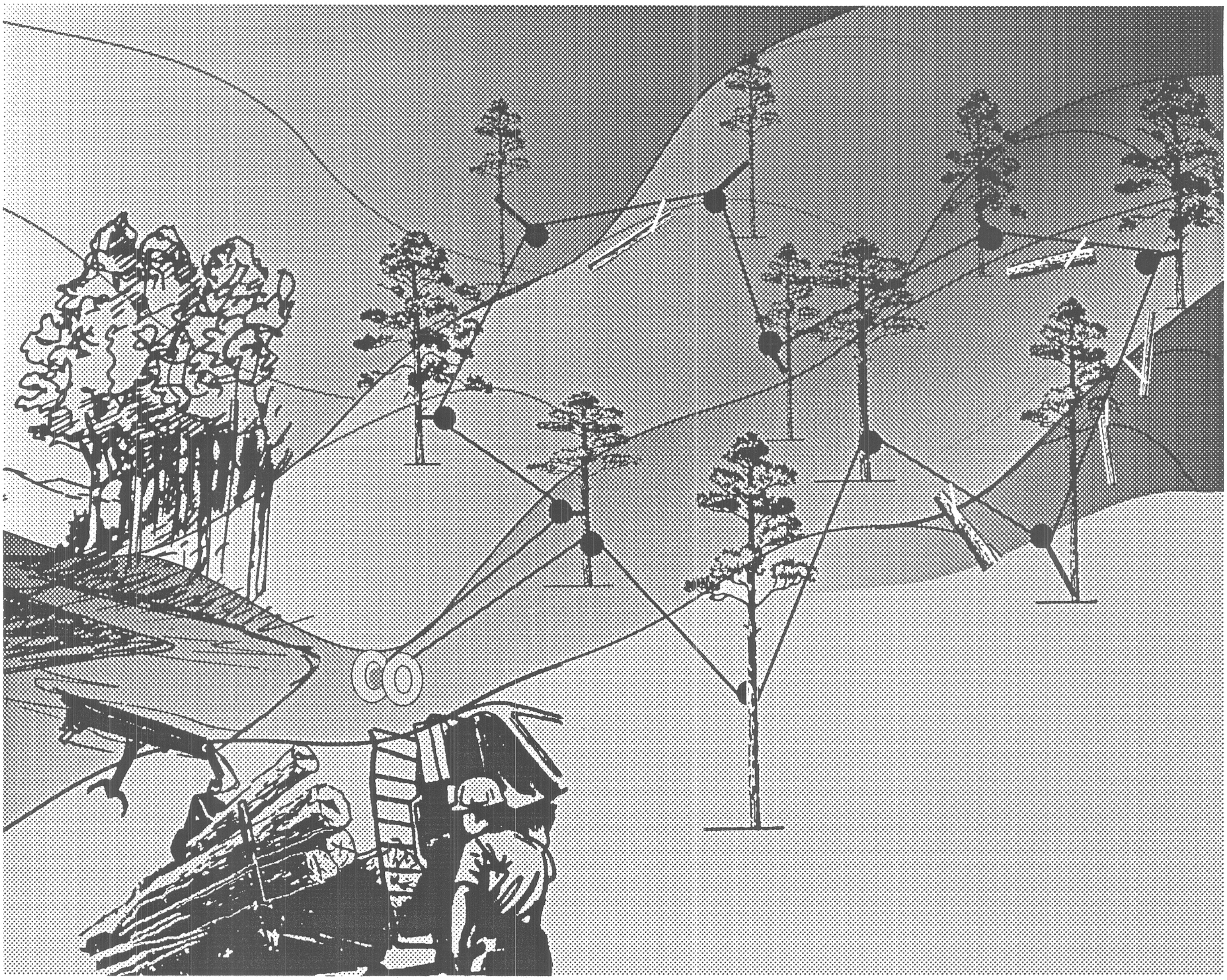

Figure 5.—A typical monocable zigzag system layout.

Numerous methods have been used to attach logs to the cable. Chokers of nylon rope or baling twine can be looped over the end of the log like a lasso and tied to the monocable with a clove hitch (two half-hitches side by side). When the log reaches the landing, the rope or twine is cut either by hand with a knife, or a blade mounted below the cable on a snatch block, such as a sandvik or sickle blade. (See figure 6, below.)

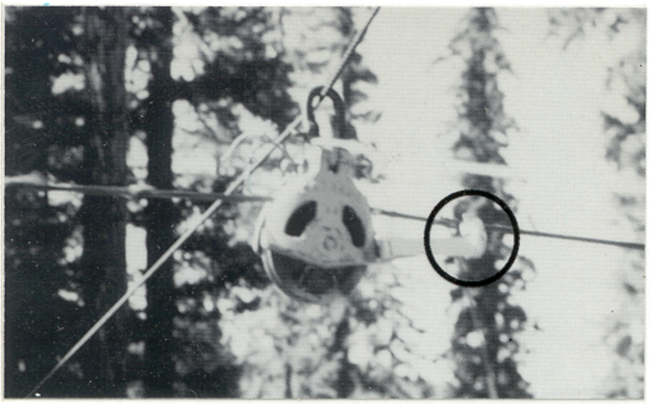

Figure 6.—Choker is cut by blade (circled) mounted below the cable on a snatch block.

Another method uses choker hooks made of steel wire 3/16 inches in diameter which are attached to the cable with clips. Chokers of any material are looped over the hooks. When logs reach the landing, the hooks are hit with a stick allowing the logs to drop to the ground.

One person is needed at the landing to move logs away from the cable, to cut the logs from the cable, or to collect the chokers if the hook system is used. (See figure 7 for landing area example.)

Logs should not be heavier than what one person can drag to the monocable. In some instances, logs 6 inches in diameter by 10 feet long have been moved 50 feet. Logs are usually attached to the cable at one end while the other end rests on the ground. If the log is too long to obtain full suspension where needed, both ends may be attached.

PRODUCTION AND COSTS CASE STUDIES

Western Oregon— Precommercial Thinning

Swanson-Superior Forest Products, Inc. of Noti, Oregon employed a zigzag system in thinning a 30-

Figure 7.—Poles and chokers move toward blade mounted below the cable on a block. Note poles tied to cable, in center of photo, moving toward block and blade.

year-old stand of overstocked suppressed Douglas Fir. About 560 trees per acre were removed. They were able to recover sufficient value in pulp-grade wood chips to defray most of the cost of the thinning operation while improving stand growth and health.

In a 4.8 acre stand with slopes up to 55 percent, 2500 feet of 3/8-inch cable was strung through 48 zigzag blocks by a four-person crew in about 4 hours. Cutters "thinned from below" by felling trees less than 6-inch stump diameter and bucking a 10-foot pole out of the butt. The largest pieces were bucked to a maximum weight of 120 pounds with the average weight 45 pounds.

Poles within about 50 feet of the monocable were carried by hand to the cable, where simple noose chokers made of sisal twine were attached. Workers then lifted one end of each pole and tied its choker to the slowly-moving cable with a clove hitch. At roadside, a cutter block severed each choker and dropped the poles onto the road. A worker hand-stacked them for later haul by a self-loading truck.

Production varied between 900 to 1400 pieces per day, or about 25 green tons. Based on an investment of approximately $15,000, including a four-person crew, the result was an estimated cost for this thinning operation of $80 an hour, or about $13 per green ton, or $160 an acre.

Swanson-Superior has employed the zigzag system for about 18 months in similar stand and terrain conditions and is committed to maintaining an ongoing program. Miller Timber Services, a contract logging firm, owns and operates the system described in this study.

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Rogue River National Forest—Slash Cleanup Following Precommercial Thinning

In 1985, a study of the zigzag system was arranged in the Bessy Creek area of the Prospect Ranger District, Rogue River National Forest. The site had been cleaned of off-site 30-year-old Ponderosa Pine, which was machine piled after felling. Rather than burn the piles, the zigzag was used to remove short log products to the roadside for later sale as firewood. Large-end diameters ranged from 3 to 13 inches and lengths from about 4 to 36 feet. The average piece was 7 inches in diameter, 9 feet long, and weighed 56 pounds. The piled trees had to be limbed, bucked, and pulled free of the piles by hand before yarding.

The 1.4-acre study area was about 650 feet from the road, across a stream, and through a stand of mature timber. No products were removed from this "dead ground." About 3000 feet of cable were needed to access the study site. The cable layout illustrated the system's terrain independence, as products moved uphill, downhill, across a stream course, and over a "blind lead" on the trip from the study area to the landing.

Zigzag blocks were spaced about 70 feet apart. Internal angle of the monocable at each block averaged 125 degrees. The system was pretensioned to about 700 pounds initially, but this was increased to about 1000 pounds in order to carry heavier pieces. The initial cable speed of about 100 feet per minute was reduced to about 50 feet per minute very early in the trial because of difficulty in tying knots on the rapidly-moving cable.

Both leading-end suspension and two-end suspension methods were tried. Products were dropped at the landing by slicing the choker with a fabricated cutter block. When two-end suspension was used, the landing person cut the rear choker first before the load reached the cutter block.

This operation was one of the first trials of the zigzag system in North America. The investigators reported that the system was very easy to understand and operate. Limited production data were collected in two scenarios:

1. Using one person to limb, buck, and free logs from the machine piles and carry them about 15 feet to the cable and another person to hook them resulted in about 50 pieces per production hour.

2. Using two people hooking in areas where products were located near the cable and requiring no preparation resulted in about 120 pieces per production hour. A third person was employed at the landing in each case to clear and stack incoming logs.

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Tahoe National Forest— Plantation Thinning and Utilization

In 1989 the Sierraville Ranger District of the Tahoe National Forest conducted a thinning in a 29-year-old pine plantation resulting from a previous wildfire. The area was quite steep (>55 percent) compared to previous zigzag operations. Equipment for this operation was borrowed from the Daniel Boone National Forest (Dick Brantigan).

The total area encompassed about six acres. Three separate setups were needed to cover the area. About three cords of pole wood per acre were removed and sold as firewood. Optimum crew size was determined to be five people plus a crew supervisor. Crew members rotated between jobs, which included felling, bucking, limbing poles, carrying pieces to the cable, hooking, stacking, and chipping. In this operation the poles were delimbed and bucked to a 2-inch top. The tops were also yarded and chipped at the landing to reduce fuel loading in the plantation.

Production information was collected for the entire operation. Average daily production (9-hour days) was five cords of firewood and an undetermined amount of chips. Production yarding the 6 acres took 281 hours. Adding setup, tear down, and supervision time raised the total to 421 hours. Forty-eight cords were removed. At an average labor rate of about $7 per hour, the treatment cost per acre worked out to about $500. The firewood was sold to partially offset the operation cost.

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