Technical RIGGING: SETTING A SPEED LINE

The challenge was to move debris from the hillside across to the truck without setting foot on the tee box areas of the golf course. The second of four tee boxes is in the foreground, the third is at center of photo. The worker has a hand on the anchor tree for the second work area.

This project earned Downey Trees Inc., of Cumming, Ga., a Grand Award in TCIA's 2005 Excellence in Arboriculture program. The award was presented at TCI EXPO in Columbus in November.

Entry Category: Technical Rigging
Size of project: Under $5,000
Type of project: Golf Course
Client: Course Superintendent
Date project started: October 15, 2004
Date completed: October 18, 2004

The goal of this project was to remove trees damaged in a series of storms in the fall 2004. The client was a prestigious golf course that hosts one of the tournaments for the Professional Golfers Association tour. The course is meticulously maintained and the cleanup had to be performed without creating any impact or disturbance to the area of play.

The trees were located on a hillside in a natural area that ran alongside a row of tees. The only route to remove the fallen/damaged trees was to go down the hill on which the trees lay, cross the tees, cross a stream, and go up a short embankment to a cart path. To accomplish this we set up a controlled speed line to move both the brush and the wood. The material was cut into small, manageable pieces, tied to a tag line, dragged across the hillside and lifted approximately 25 feet onto the speed line. Once elevated, the material was transported over the fairway, across the stream and up the embankment to the landing zone next to the cart path. The brush was chipped and wood was staged for pickup with a grapple truck.

Trees impacted by the project

Several trees damaged by the storm were removed. They included white oak, *Quercus alba*; southern red oak, *Quercus falcata*; flowering dogwood, *Cornus florida*; and sourwood, *Oxydendrum arboreum*.

Two of the trees were completely uprooted by the storm, one was partially uprooted and leaning into another tree, and one had a large broken lead that had fallen and needed to be removed. All of these stood on a steep bank and were part of a natural area that was immediately adjacent to the golf course.

Challenges in the project

The challenge was not in getting the trees down, but in moving them out of the area. The damaged trees and natural area were on one side of a row of tees (men's, women's, tournament, and an alternate) that stretched for about 150 feet at the beginning of one hole. We could not walk on any of the tees at any time (unless we were wearing golf shoes), and we could only walk on the grass between and around the tees as long as we did not cause any damage to the grass. On the other (left) side of the course was a stream that could be crossed by two different bridges in the area in which we were working. The terrain sloped up from the stream to where the cart path was, approximately 10-15 feet above the level of the course.

There was a large amount of material from the trees and it was spread for a length of about 100 feet along the tees. Carrying the material out by hand would have required literally hundreds of trips across the grass and up the embankment to the cart path. The material could have been cut and placed in a golf cart type vehicle, but this would also have required many trips across the grass. Either method would have created worn areas on the grass around the tees so we had to find some other way to get the material off of the hillside and over to the cart path.

Looking across the cart path, stream and tees to the hillside where the storm damage occurred. The pickup used to tension the speed line is just out of view on the right on the cart path. The pull line has been reset and is slack.

Overcoming the challenges

We set up a controlled speed line that allowed us to lift and transport the material over the tees and stream, and then lower it into the landing zone.

A speed line is typically used to move material from somewhere in the tree top to an area that is adjacent to, but not immediately below, the tree. In this instance the material was already on the ground, spread out over a hillside, and was over 200 feet from the landing zone where the material was to be processed. We designed a system that would allow us to drag the material to the tree where the speed line was anchored, lift the material into the air, transport the material down the speed line, and then release the material at the landing zone. Because the material was spread out over such a long distance, we set up the whole system twice so that we could have two different landing zones and use two different anchor points. (All the photographs show the setup for the second work area.)

A log has been hauled into the air and is ready to be lowered on the speed line.

Hazards and accident prevention

This job presented two areas of concern that were different from routine climbing and rigging. The first included the dangers of working on a hillside. The second was the speed line itself, which was closer than usual to ground level, was frequently under tension and had a redirect near the landing zone. Workers were made aware of the dangers of walking, cutting and moving wood and brush on a hillside. They were told to always position themselves outside of all parts of the rigging, and not to go below the suspended material, except when necessary to release it from the speed line.

Rigging methods used

A ¾-ton pickup truck with a front-mounted winch was positioned on the cart path on the far left side of the tees. The winch line was attached to the speed line, which ran from the winch line through a redirect pulley mounted on either a tree (for the first set up) or a chip truck (for the second set up), across the tees, and was anchored approximately 30 feet high on a tree in the middle of the hillside. The tension of the speed line could thus be monitored and controlled by the winch of the pickup truck for every piece that was moved across the tees.

A pulley placed on the speed line served as both (1) the anchor point for the pulley that would drag and lift the material and (2) as the speed line pulley to move the material across the tees. The speed line pulley had two work lines attached to it. One of the work lines ran through a Pro-Traxion (ratcheting clamp) that was attached to the speed line pulley with a carabiner. The Pro-Traxion was used to drag the material to the base of the tree where the speed line was terminated and then lift and suspend the material in the air. This line could run freely in one direction (when the material was ulled along the ground and then into the air), but would hold securely in the other direction when tension was released.

Pulling and lifting the material was accomplished with a small, walk behind skid steer. The skid steer was positioned at the end of one of the bridges, just at the edge of the course proper. The pull line ran from the skid steer, through the Pro-Traxion, and was then tied to the piece that was to be moved. Once the material was tied off, the skid steer would back across the bridge, pulling the material across the hill and then lifting it into the air. The skid steer would continue to back up, going along the embankment beside the stream as far as was needed to lift the material up to the speed line. If the piece that was being moved was a long way from the anchor tree (and thus had to be dragged a long distance before it was lifted into the air) the skid steer would have to stop, untie the pull line, drive forward, retie the pull line, and then continue to back up and lift the piece.

A second line was used to hold the speed line pulley in place while the material was being dragged and lifted, and this same line was used to control the descent of the material as it traveled above and across the tees and the stream. The redirect on the landing zone had been positioned so that after the material crossed the stream and reached that side, the material would be only about 4 to 6 feet above the ground. The tension on the winch line was relaxed and the material was lowered. Wood was caught with a small skid steer and brush was directed toward the cart path where it could be chipped. After the material was detached from the pulley, a sufficient amount of the pull line was run back through the Pro-Traxion so that the workers on the hillside would have enough slack to walk the rope to the next load of material and tie it with the pull line.

Ropes and equipment

The speed line itself was a piece of 7x7x19 wire rope that had been cut to length for this specific job. The pulley that ran on the speed line was made for running on wire rope. It had a single, closed eye that pivoted 360 degrees. The speed line was attached to the anchor tree with a Tuflex sling, EN 60.

The pull line was ½-inch 12-strand (Samson Arborplex). We debated using ½ inch double braid for the pull line, but this line would be dragged through mud and dirt and would be exposed to the toothed cam of the Pro-Traxion. The 12-strand has more abrasion resistance than double braid and it was not felt that the extra strength of the double braid was necessary.

The pull line had to run freely in one direction (so that the material could be pulled along the ground and then into the air), but had to hold securely in the other direction when tension was released. We used two different methods for this purpose. For the first setup, a large rescue pulley was attached to the eye of the speed line pulley with a steel carabiner. A friction hitch with a slack tender was placed on the pull line and anchored to the carabiner that attached the rescue pulley to the eye of the speed line pulley. The friction hitch functioned just as an arborist's climbing hitch. The rescue pulley allowed us to pull and lift the material, and the friction hitch held

The wire rope running across the top is the speed line. The speed line pulley is on the wire rope. The carabiner on the left side of the eye of the speed line pulley is attached to the Pro-Traxion. The rope running through the Pro-Traxion is the pull rope. The left side of this rope is tied to the skid steer and the right side (hanging down) is tied to the material (wood/branches). The two carabiners on the right are attached to the control/haul back line.

whatever amount of line had been pulled through the rescue pulley to that point. Thus the material could be moved across the ground, lifted into the air, and the friction hitch would keep the material suspended when the pull line was slackened and untied from the skid steer. For the second setup the friction hitch/slack tender was replaced with a Pro-Traxion. This is a device that contains both a pulley and a cam and is described as a "swing-sided, self jamming pulley." Because the side of the pulley swings, the Pro-Traxion can easily be placed anywhere on the line. The line can run freely over the pulley in one direction, but is prevented from running in the other direction by the cam.

The control/haul back line was ½-inch double-braid. The control line was redirected with a ¾-inch block that was attached to the anchor tree with a 5/8-inch, 2- to 6-foot Tenex whoopie sling. The friction device that held the control line was a Port-a-Wrap III.

Determining safe working loads

A green log weight table was referenced to help gauge the weight of the logs. The weight and appropriate size of the loads of brush were estimated based on our experience with using a Load Moment Indicator during crane removals and by observing the speed line system as it was in use. We aimed to keep all of the material that was lifted with the pull line and transported with the speed line at less than 600 pounds. This would keep all of the loads within the safe working load (SWL) for each of the different components of the system.

Calculations for estimating the force on a speed line are quite complicated and depend upon a number of variables. In order to keep the calculations reasonably accurate, but not overly complicated, we figured forces for two main scenarios – lifting the material, and running the material down the speed line. Also, although we wanted to keep loads at or below 600 pounds, there is some variability and subjectivity involved with guessing loads. We therefore used 700 pounds as the basis for our calculations.

When the material was being held in the air by the skid steer and the speed line pulley was close to the anchor tree, the pull

A worker "catches" a log with the skid steer.

line was under tension as it held the material in the air and the control/haul back line was under tension as it prevented the material from running down the speed line. The angle formed by the pull line was approximately 120 degrees and the angle formed by the control line was approximately 90 degrees. When there is an object hanging on a block, the resultant force on the block is more than the actual weight of the object. The resultant force depends on the angle of the two legs of the rope. We used a "Resultant Force on Block" chart that shows that when the angle of the rope is 120 degrees the resultant force on the block is 1.73 times the weight of the piece. For the 700 pound piece that is used as the example in this case the resultant force would be 700 x 1.73 = 1,211 pounds. The Pro-Traxion and the carabiner that held the Pro-Traxion experienced all of this force. The Pro-Traxion is the weaker of these items, with a tensile strength of 22kN. A force of 1,211 pounds means that there was a safety factor of 4:1.

Because of the vectors involved, the speed line, speed line pulley and control line all shared the load of 1,211 pounds as they held the Pro-Traxion in place. Since all have a higher rating than the Pro-Traxion, the Pro-Traxion was the limiting factor.

The control line formed a 90 degree angle as it was redirected through the pulley on the anchor tree and down to the Port-a-Wrap at the base of the tree. The same chart shows that a rope bent to 90 degrees exerts a force on the block/pulley that is equal to 1.41 times the weight of the load. If we assume that the control line held the full force that was on the Pro-Traxion, then the force on the redirect pulley of the control line would be 1,211 pounds times 1.41 = 1,707 pounds. This estimate is probably high, but it is still well within the capacity of the block (SWL = 4,000 pounds) and sling (SWL = 2,560 pounds) and yields a safety factor that is higher than the 4:1 of the Pro-Traxion.

When the skid steer relaxed its pull and the material was simply hanging on the pull line the forces on the various parts of the system changed. The force on the Pro-Traxion would now be simply the weight of the piece, 700 pounds. Because the vector forces had changed, the control line would experience less force, but the speed line pulley would experience virtually all of the force of the weight of the piece. The SWL for the speed line pulley was 1,500 pounds, so the 700 pounds force of the weight of the piece would be well within this limit.

We used a second chart, "Sling Angles and Resulting Tension," that shows that as the angle of the legs of a sling becomes more obtuse, the force on the legs becomes greater. In the case of the speed line, the legs of the sling equate to the angles of the legs of the speed line on either side of the speed line pulley. The legs of the speed line were estimated to be at an angle of about 150 degrees. The "Sling Angles and Resulting Tension" chart shows that this angle produces a force on the sling/speed line that is twice the actual weight of the piece. Thus the force on the speed line, with the piece just hanging on the Pro-Traxion, is twice the weight of the piece, 700 pounds x 2 = 1,400 pounds. The manufacturer's recommended SWL for the cable used for the speed line was 3,500 pounds. (We carefully checked the ratings for all of the equipment and found that the manufacturer's recommended SWL of 3,500 pounds for the cable was based on a safety factor of only 2:1. By keeping our material loads at a (high) estimate of 700 pounds, we maintained a safety factor of 5:1 for the speed line cable.)

A SWL of 600 pounds would provide a safety factor of 4:1, and, considering all the factors discussed above, we determined this was a reasonable SWL for this system. The material was all lifted in a controlled, methodical manner so no part of the system was subjected to any dynamic loading. After each piece was lowered into the landing zone, the pull line had to be run back through the Pro-Traxion, so this gave an opportunity to closely inspect the pull line, Pro-Traxion, speed line pulley and associated connectors. We also closely inspected the cable when moving it from the first to the second work area and found no signs of abrasion, overload or excessive wear.

The rigging greatly lessened the project's impact to the surroundings

The speed line allowed us to move two truck loads of wood and one load of chips from the hillside, across the fairway to the other side without creating any impact at all to the tees or the surrounding turf. The tees received absolutely no damage or wear and could be used for play as soon as the work was completed.