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THE D5H CABLE TRACKED SKIDDER IN BOTH UPHILL AND DOWNHILL EXTRACTION

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Figure 1 - D5H cable tracked skidder extracting uphill in Kaingaroa Forest

ABSTRACT

This Report is one of a series of evaluations of Caterpillar high drive tracked skidders. This study was undertaken to investigate the productivity of a Caterpillar D5H cable tracked skidder in uphill and downhill hauling conditions. Mean extracted piece size was 2.1m³ and the average haul distance was 126 metres. Calculated average hourly productivity, with a mean haul size of 6.3m³, was 37m³ per productive machine hour.

INTRODUCTION

The Caterpillar tracked skidders, the production line models of the custom skidder, are a recent innovation in ground based skidding equipment. To introduce this new range of equipment to the New Zealand logging industry, Caterpillar agents, Gough, Gough and Hamer, made available a D5H cable tracked skidder for several contractors to test in a production situation.

The objective of this study was to evaluate the performance of a D5H cable machine in uphill and downhill hauling conditions. It was also intended to gather some data on the tracking performance of this machine.

During the course of the evaluation, three different operators, with varying degrees of skill, operated the tractor. In addition to the operator, either one or two breakerouts were used.

Previous LIRO studies have evaluated the D4H custom skidder (Hill, 1991a) and the D5H grapple tracked skidder (Hill, 1992).

It is envisaged that tracked skidders will often be used in uphill logging as well as logging on flat terrain. The effects on productivity of changes in haul slope are as yet unexplored.

ACKNOWLEDGEMENTS

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THE MACHINE

The new Caterpillar tracked skidders are noted for their improved side slope mobility by virtue of a wider track base and a forward centre of gravity. They are also characterised by higher ground clearance and a hydraulic lift, power down, power angle and tilt blade.

The machine evaluated in this study was a Caterpillar D5H Series II cable tracked skidder. Basic machine specifications are given in Table 1.

Cat Model 3304 T Turbo Charged Diesel Engine	90 kW (120 hp)
Operating Weight	15 141 kg (cable)
Travel Speed (maximum)	10.9 km/hr
Track Rollers	7
Track Length (on ground)	2.74m
Winch : Line Pull Maximum at Stall	31400 kg
Ground Clearance	478 mm

Table 1 - Machine specifications

STUDY AREA

	Compartment:	
	1280	1281
Stand Age (years)	38	38
Mean DBH (cm)	44	50
Mean Top Height (m)	44	43
Mean Merch. Volume (m^3)	2.07	3.14

Table 2 - Stand details

The study was undertaken in September, 1991 in Compartments 1280 and 1281 in the northern boundary area of Kaingaroa Forest. The two uphill hauling sites were both gullies rather than even slopes, averaging 12°. One downhill hauling site was studied, the upper part being accessed by an 15° access track. Downhill extraction slopes averaged 10°.

STUDY METHOD

A continuous time study method was used to collect data from 65 uphill cycles and 52 downhill cycles. A total of 117 cycles were timed.

Data collection included times for cleaning up the skid site (fleeting) and tracking or blading. Operational delays, such as loader interference, were also included in the study. The butt diameter of each tree pulled during the study, the number of tree lengths per cycle, travel empty and travel loaded times were also recorded. If a short log was hooked on, both large end, small end and length were measured so that the volume of short logs could be calculated.

Log volume calculation of a sample of 111 individual trees gave a mean extracted volume of 2.3m^3 per tree. The relationship of butt diameter to tree volume (r^2 = 0.90) was used to calculate individual cycle volumes for both uphill and downhill extraction.

RESULTS AND DISCUSSION

The measured cycle times and the productivity of the D5H cable tracked skidder are summarised in Table 3. There was no significant difference between the mean haul sizes from uphill extraction in the two compartments, so these data were grouped for analysis. Travel loaded and travel empty times have been standardised at 150 metres to facilitate a comparison between uphill and downhill extraction.

The average distance for uphill hauling, loaded, was 85 metres with a mean travel empty distance of 91 metres. For downhill hauling, mean distance loaded was 89 metres with a mean travel empty distance of 93 metres. Maximum haul distance uphill was 200 metres and downhill 230 metres.

Travel loaded times for uphill logging were found to be significantly different to downhill travel loaded times. For this reason the work cycles of the two different haul directions were analysed separately.

The average productive cycle time for uphill hauling was 11.1 minutes with an average haul volume of 5.14m^3. This equates to an average productivity level of 27.8m^3/PMH. Excluded from this calculation is the time spent tracking. During the study period, 62 minutes were spent tracking, of which 44 minutes were

Element	UPHILL Per Cycle (mins) Mean	UPHILL 95% Confidence Limits	DOWNHILL Per Cycle (mins) Mean	DOWNHILL 95% Confidence Limits
Productive				
Fleeting	0.15	0.03	0.04	0.07
Run empty(40m)	0.61	0.04	0.63	0.08
Travel empty	1.42	-	2.42	-
Position	0.64	0.21	0.86	0.23
Hook on	2.08	0.21	2.92	0.50
Blading	0.97	0.23	0.25	0.19
Winch	1.37	0.29	1.86	0.36
Travel loaded	2.76	-	1.85	-
Run loaded(41m)	0.72	0.04	0.82	0.12
Unhook	0.38	0.05	0.43	0.09
Productive Cycle Time	11.10		12.08	
Non productive		Occurrence		Occurrence
Operational delay	0.16	11	0.45	14
Personal delay	0.15	12	0.15	6
Mechanical delay	0.53	6	0.09	4
Tracking delay	0.27	9	0.84	12
Sub Total delays	1.11		1.53	
Total Cycle time (min)	12.21		13.61	
Slope (degrees)	+12		-10	
Trees/cycle	2.95	0.20	3.06	0.31
Mean extracted piece size (m^3)	1.74		2.52	
Haul volume (m^3)	5.14	0.44	7.71	0.86

Table 3 - D5H Cable Tracked Skidder Work Cycle

spent putting in a 30 metre, 15° access track across a steep 35° face, during downhill extraction.

The average productive cycle time for downhill hauling was 12.08 minutes, with an average haul size of 7.71m^3. This equates to a productivity level of 38.3m^3/PMH. Data in Table 3 would suggest that winch time was significantly greater for downhill logging but tests showed that this was not the case.

Haul size was found to be a poor predictor of travel loaded time in this instance, possibly because of the operator's work method of not overloading the tractor on uphill hauls. On downhill hauls the haul sizes also appeared to be within the machine's capacity.

A previous study had indicated a tendency for some operators to increase haul sizes on longer hauls, to increase their production (Hill, 1991b). There was no evidence of this operating method in this study, possibly because the operator was not yet familiar with the machine.

The travel empty and travel loaded times in Table 3 were estimated using the following regression equations:

Uphill

Travel empty (min)
= 0.075 + 0.009 x *Distance (m)*
$r^2 = 0.93$

Travel loaded (min) =
0.206 + 0.017 x *Distance (m)*
$r^2 = 0.80$

Downhill

Travel empty (min) =
-0.132 + 0.017 x *Distance (m)*
$r^2 = 0.83$

Travel loaded (min) =
0.349 + 0.010 x *Distance (m)*
$r^2 = 0.52$

The main factors affecting tracked skidder productivity as studied, were the haul distance travelled and the direction of haul. In other tractor downhill extraction operations, it has been found that the travel empty distance is an important factor and can, in steep terrain be up to 30% greater than the travel loaded distance (Evanson, 1992 in prep).

The formation of a section of track was timed and the track measured to calculate the rate of tracking progress. Ground slope at right angles to the track direction was also measured as was the slope of the track itself. For a track of length 176 metres the rate of progress was 2.2 metres per minute. The track was formed at an average 15° downhill, with the average 27° ground slope, mean track width was 3 metres (no fill width included).The track route was through standing trees and two small trees were pushed over without problems. A large stump however took 15 minutes to dislodge.

COST ANALYSIS

Estimates of the daily cost of the operation were established assuming a seven man crew (2 fallers, 2 skid workers, 1 breaker out and 2 machine operators) using the LIRA costing format (Wells, 1981). The D5H cable tracked skidder has a capital cost of $300,000 and a Volvo BM L90 has a capital cost of $221,000.

	Cost ($)
D5H Custom Skidder	529
Volvo BM L90 Rubber Tyred Loader	397
7 Men including Saws	1120
Vehicle (130 km @ $0.55/km)	72
Overheads and Supplies (2½%)	53
Profit (10%)	212
TOTAL ($/day)	2383

Table 5 - Daily cost of a D5H Cable Tracked Skidder Operation

CONCLUSIONS

In conditions of 1.7m³ extracted piece size and 150 metre average haul distance, uphill extraction by D5H cable tracked skidder is estimated to have produced 28m³/PMH or 182m³/day (6.5 PMH). The unit cost of extraction under these conditions is estimated to be $13.09/m³ on truck.

Correspondingly, in conditions of 2.5m³ extracted piece size and 150 metre average haul distance, downhill extraction by the D5H is estimated to have produced 38m³/PMH or 247m³/day (6.5 PMH). This level of production corresponds to a unit cost of $9.65/m³ on truck.

The study showed that the performance of the D5H cable tracked skidder varied significantly according to its use for downhill or uphill hauling operations. It can be expected that productivity rates of more experienced operators would differ from those demonstrated in this study.

There were indications that when tracking is to be undertaken, consideration should be given to using a specialist machine if significant numbers of stumps are to be removed. The D5H appeared to cope well with smaller standing trees.

Further LIRO studies will focus on the investigation of tracking requirements for steep terrain operations.

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The costs stated in this Report have been derived using the procedure shown in the LIRA Costing Handbook for Logging Contractors. They are an indicative estimate and do not necessarily represent the actual costs for this operation.

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