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Short-term evaluation of the Kobelco BladeRunner ED150 for road rehabilitation

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Keywords

Road construction, road rehabilitation, road maintenance

Abstract

FPInnovations performed short-term productivity studies on a road rehabilitation operation that utilized a Kobelco ED150 BladeRunner. The BladeRunner is a multi-purpose machine that can function as an excavator and a bulldozer, due to its front blade attachment. Productivity studies were also performed on an excavator (John Deere 200C) and bulldozer (Caterpillar D6M) team that performed the same work as the BladeRunner.

INTRODUCTION

The rehabilitation of existing roads is an important component of forest road management activities. Following the completion of forest harvesting operations, roads may remain dormant for a period of up to 20 years, until the forest stand reaches an age when harvesting operations are again planned. During this period of inactivity, organic material and debris may have accumulated on the road, ditches may have slumped and filled in, and vegetation and trees may have become established on the roadbed. When it is time to return for forest harvesting, the roads must be upgraded and maintained, in order to support the required heavy and light vehicle traffic.

The following report outlines the work methods and productivity results, as determined by FPInnovations, following short-term studies conducted in the fall of 2012 with J.D. Irving Limited in New Brunswick.

MACHINE DESCRIPTION

The Kobelco BladeRunner (Figure 1) is a multi-purpose machine that offers both excavator and bulldozer functions. The machine has a 6-way bulldozer blade (3.2 m wide and 0.85 m high) that can perform full bulldozing functions, and is equipped with a bucket capacity of 0.67 m^3. The Kobelco BladeRunner includes the ED150 94 hp, 16 000 kg model and the larger ED195 121 hp, 20 000 kg model. The model in this study was a 2004 ED150 with 4800 engine hours.

The manufacturing of the ED150 and ED195 models ceased in 2008 and 2012, and they are currently only available in Canada as used machines. However, Kobelco has announced that a new BladeRunner ED160, which includes various enhancements such as safety and fuel consumption improvements, is now available for the Canadian market.

Figure 1. View of Kobelco BladeRunner ED150.

STUDY DESCRIPTION

The study sites were located in northwestern New Brunswick on the woodland operations of J.D. Irving Limited's Black Brook district. Two study sites were chosen in order to facilitate the productivity studies of the Kobelco BladeRunner ED150 and the road construction team of a John Deere 200C excavator and Caterpillar D6M bulldozer (Figure 2). The study sites were selected to focus on the rehabilitation of 20-year-old bulldozer-built roads, which were to be rehabilitated to support commercial thinning forest operations. The existing right of way had been cleared by a harvester prior to the start of the productivity studies. The study sites were chosen to represent conditions as similar as possible, in terms of soil types, terrain slope, and right of way width. Site 1 had slightly drier soil conditions at the time of the study and was located in relatively flat terrain, with an organic soil layer of 0.4 m overlying the shale material used as the road material. Site 2 was located in undulating terrain, with an organic soil layer of 0.6 m overlying a shale material.

Figure 2. View of Site 1 (left) and Site 2 (right), following clearing by the harvester.

STUDY METHODS

FPInnovations conducted productivity studies for the Kobelco BladeRunner, and the excavator and bulldozer team, during two site visits in September and October 2012. The experienced machine operators were instructed to follow their standard work procedures and methods, which had been communicated by the forest company.

The Kobelco BladeRunner was observed operating during both site visits for a total of approximately 23 productive machine hours (PMH), and the results were combined to develop overall averages. The excavator and bulldozer team were studied during the second field visit for a total of approximately 9 PMH.

Detailed timing studies were performed by FPInnovations, capturing the various work phases of each machine. The forest company had outlined typical construction phases used by the machine operators for conducting road rehabilitation operations. The following construction phases, which were followed both by the Kobelco BladeRunner and the excavator and bulldozer teams, were observed and recorded by FPInnovations:

- stripping vegetation and organic material from the road surface; then stockpiling the material at the edge of the right of way;
- digging a trench along the ditch line, to access road building material, and windrowing the excavated material along the road centerline;
- filling the trench with the stockpiled organic material after the required road building material has been removed and windrowed;
- performing final grading of the road surface with the windrowed material and contouring the ditch slopes.

RESULTS AND DISCUSSION

Despite minor site differences, there were enough similarities to allow for a comparison between the two road construction methods that were studied (Figure 3).The final road characteristics were similar, with a final road surface width of 4.4 m at both sites. The site where the excavator and bulldozer team operated had a slightly thicker layer of finished road grade of 0.51 m, as compared to 0.45 m for the Kobelco BladeRunner. The roads built in this study provided access through a commercial thinning harvest block, and due to this, the forest company targeted a narrow right-of-way width of 8 - 9 m. The Kobelco BladeRunner, due to its smaller size, was better suited to work within the narrow right-of-way and achieved an average width of 9.3 m, versus 11.1 m for the excavator and bulldozer team.

Figure 3. Final road surface, as completed by the Kobelco BladeRunner ED150 (left) and the excavator and bulldozer team (right).

The main factor to consider, in terms of machine productivity between the two sites, besides operator differences, was the wet weather conditions in which the excavator and bulldozer team operated. The wet weather, combined with the higher clay content at this site, may have influenced machine productivity.

The productivity observations (Table 1) made by FPInnovations reinforced the assumptions made by the forest company in regards to the time spent at each task by each of the machines. Although efficient in each of its assigned tasks, the excavator and bulldozer team incurs higher operational delays, which significantly contribute to a reduction in the team's productivity and equipment utilization. This is best highlighted by the bulldozer, where 46% of its time was spent waiting for the excavator to complete additional trenching, so that the bulldozer may continue with the tasks of filling the trench and grading the road surface.

Table 1. Total productive machine time distribution over period of study

Work phase	Machine time spent in each work phase (% of total time)		
	Kobelco BladeRunner	John Deere 200C Excavator	Caterpillar D6M Bulldozer
Stripping	14	-	7
Trenching	51	80	-
Filling trench	22	6	28
Grading	9	-	11
Operational delay [a]	3	8	3
Waiting [b]	-	2	46
Non-operational delay [c]	1	4	5

[a] Operational delays; are considered by FPInnovations to be such activities as operator breaks (less than 15 minutes), machine repairs, talking to supervisor, amongst others.

[b] Waiting; is considered by FPInnovations to be such activities as waiting for another machine to complete a task before continuing with productive effort.

[c] Non-operational delays; are considered by FPInnovations to be such activities as operator breaks (longer than 15 minutes), delays caused by the research activities of FPInnovations, amongst others.

The productivity results presented in Table 2 illustrate that the excavator/bulldozer team was more productive than the Kobelco BladeRunner. This result was clear, despite the short term in which the productivity study was performed for the excavator and bulldozer team, and was in line with the results anticipated by FPInnovations and the forest company. However, when the overall average for machine productivity is considered between the two work teams, it becomes apparent that cost savings are possible through the use of the Kobelco BladeRunner.

The overall productivity of the Kobelco BladeRunner, was found to be 24 m/PMH throughout the study. The excavator/bulldozer team was faster, in terms of the individual machines, for each of the work phases and in their respective overall averages of 43 and 95 m/PMH. However, the machines in the excavator/bulldozer team were responsible for specific work phases in the construction sequence and, with the exception of the filling trench work phase, machine work phases must be followed in sequence. Considering this, the average machine productivity of the team is only as fast as the slowest machine; in this case, that is the excavator.

Table 2. Machine productivity and cost comparison for the two systems

Work phase	Average machine productivity for each work phase (m/PMH)		
	Kobelco BladeRunner	John Deere 200C Excavator	Caterpillar D6M Bulldozer
Cost per hour [a] ($/PMH)	118	134	144
Productivity (m/PMH)	24	43	43
Cost per kilometre of road ($/km)	4 916	3 120	3 350
Total cost for each system ($/km)	4 916	6 465	

[a] FPInnovations average machine values.

The Kobelco BladeRunner has a smaller bulldozing capability than the Caterpillar D6M. However, during the study, FPInnovations did not observe instances where the Kobelco BladeRunner was underpowered for the required task. The Kobelco and the Caterpillar share a similar blade width of 3.4 m, but the Caterpillar blade is 0.4 m higher and has an engine rated horsepower of 150 hp compared to 94 hp for the Kobelco. The machine operator did comment that the Kobelco may encounter challenges in grading if the material is wet and has heavy clay content, though these conditions were not encountered during the study.

The productivity results found indicate that the Kobelco BladeRunner could cost approximately 24% less to build one kilometre of forest road, given conditions similar to those encountered in this study. The lower productivity of the Kobelco is offset by the much lower operating cost of the machine, when compared with the excavator and bulldozer included in this study. The road construction costs of the excavator and bulldozer team are hampered by the approximately 50% of idle time incurred by the bulldozer, as it waits for the excavator to finish the trenching phase, before it can complete the final grading phase. Even though the results of this study indicate that the Kobelco BladeRunner is a lower-cost option, it achieves this with a productivity level that is just 55% of the excavator and bulldozer team. In order to achieve the same annual levels of road building as the excavator and bulldozer team, the Kobelco would need to be scheduled for longer shifts or the road building season would need to be extended.

The fuel consumption of the equipment was also recorded by FPInnovations each time the operator refueled the machines. FPInnovations observed fuel consumption levels of 24.6 litres/PMH for the Kobelco BladeRunner, 28.8 litres/PMH for the excavator, and 37.0 litres/PMH for the bulldozer. The Kobelco BladeRunner operator commented that more frequent refueling was required because the fuel tank size was only sufficient for providing fuel for one operating shift.

CONCLUSIONS

FPInnovations conducted short-term machine productivity studies on two road construction equipment teams who were rehabilitating roads that had not been maintained for twenty years in order to support planned commercial thinning operations. The Kobelco BladeRunner ED150 was studied and compared to the current equipment team: a John Deere 200C excavator and Caterpillar D6M bulldozer.

The results indicate that the Kobelco BladeRunner was able to perform at a productive rate of 24 m/PMH for a total road construction cost of $4 916/km. The excavator and bulldozer were each able to perform their dedicated work phases at a productive rate of 43 and 95 m/PMH respectively. However, high wait delays incurred by the bulldozer, while it waited for the excavator to finish trenching, reduced the equipment team's overall productivity. As a result, these studies found a total road construction cost of $6 465/km for the excavator and bulldozer team, based on a combined productivity rate of 43 m/PMH.

The overall road construction costs of the Kobelco BladeRunner were found to be 24% less than the excavator and bulldozer team. However, the lowered cost was at the expense of productivity, since the Kobelco could only achieve a productivity rate of 55% of the two-machine system.

The short-term machine productivity study performed by FPInnovations indicated that the Kobelco BladeRunner may be a suitable alternative to the excavator and bulldozer team when performing road rehabilitation in conditions observed in this study. The ability of the Kobelco BladeRunner to perform both digging and grading tasks was advantageous to this operation. Additional studies, across a variety of operating conditions, would further aid in determining the suitability of this machine for performing in road rehabilitation operations.

IMPLEMENTATION

The use of a Kobelco BladeRunner ED150 may be a feasible alternative to traditional excavator and/or bulldozer road rehabilitation teams. A few observations from these short-term FPInnovations studies may aid in its implementation:

- The fuel capacity of the Kobelco BladeRunner may not be enough for a complete shift; the capacity for refueling must be kept nearby.
- The lower productivity of the BladeRunner will necessitate the scheduling of additional shifts or an extension of the scheduled time for road rehabilitation, in order to achieve the desired construction levels.
- Possible safety protocols for having operators working alone will need to be addressed, if this is a concern in an operation where the Kobelco BladeRunner is operating.
- The larger Kobelco BladeRunner ED195 may be considered more suitable, due to its higher bucket and blade capacities and horsepower, for forest road rehabilitation rather than the smaller ED150 which was a part of this study.
- The ED195 and ED150 models are no longer manufactured and have been replaced by the new ED160, which includes various enhancements such as safety and fuel consumption improvements and offers similar specifications to the ED150.

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