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Efficiency of Timber Jack 450C with Different Loading Volumes in Different Slopes

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Abstract: Primary transportation is an upper time, expensive and hard labour. The most skidding are with using of rubber wheel of Timber jack 450C in Iran country that has devoted 60% of utilization expenses. In order to, investigate of slope and loading volume effects on time of loaded traveling had used time study for Timberjack 450C. In one of strip roads in parcel eleven of district two of Langa management plan forest (Kelardasht region in North of Iran) determined 5 and 3 different slopes classes and volumes classes, respectively. Then, time study was performed in slope classes with different loading volume in downward skidding. The first, collection of data have noted in special form and then have converted to uniform unit of m sec^{-1}. Descriptive statistics for each data set were calculated using the SPSS software. With presupposition that loading volume and slope are effective on the obtained time, these parameters have analyzed. ANOVA and Tukey test were used for loading volume factor. For investigation slope factor had used of Mann Whitney non-parametric test in order to comparison of loaded traveling speed in different slopes. Results of present research had showed that influence of loading volume on the loaded traveling time is insignificant, but loaded traveling speed in different slope classes is significant (in slopes >30%) as, speed of skidder machine is decreased with increase of slope variable.

Key words: Loaded traveling time, slope, loading volume, skidding, Timber jack 450C, Langa

INTRODUCTION

Almost, 7% of Iran country area is covered with forest. 1.9 million hectare areas of this forests are situated in southern of Caspian that have merchant value. This forest is known to hyrcanian forests and valuable of genetic viewpoint due to this forests are biotic fossil of European forests (Yakhkeshi, 2003). Primary transportation is one of the most sensitive, the most expensive and hard level of forest utilization (Sarikhani, 2001). This process is the most doing by means of ground crawlers with using of strip roads and machine roads planning in north of Iran. Differences of strip roads and machine roads are differences of their standards and don't excavate and earth filling in strip roads (strip roads cleanse of brows and stones will have done by using of crawler machines) (Mcmorland, 1981; Froehlich *et al.*, 1997; Garland, 1997; Bombosch *et al.*, 2003).

Nowadays, with expansion of mechanized machines, determine of machines useful efficiency in skidding is necessary. Ancient skidders (almost 3 m³) and Timber jack 450C skidder (almost 10 m³) are enabling to transport of loading in suitable conditions and downward skidding. In downward skidding, skidding time is depended to number of logs, skidding distance, loading volume and strip roads slope (Naghdi and Sobhani, 2001) but, Lotfalian (2001) was mentioned that loading volume, number of logs and strip roads slope factors are no effective in loaded traveling time in downward slopes.

Determination loading volume (dimensions, size and weight) are the important factors for skidding with skidder (Abeli, 1996; Garland *et al.*, 2003; Naghdi, 2004) and this process is depended to slope (in direction of skidding), skidder weight and its power, conditions and dimensions of wood. Loading skidding power is depended to skidder power and rubber coefficient between logs and ground. This subject is important because of skidding operation with 80% of skidder power, skidder efficiency is well but loading volume is equal to 100% of skidder power, almost 33% added to time of skidding (Sarikhani, 2001). In positive slopes, the maximum time out of wood is double opposite of negative slope (Mostafanejad, 2006).

Time of skidding will increase with increase of loading volume in every time (Naghdi and Sobhani, 2001; Jourgholami, 2005) as, loading volume is effective on skidding time (special in upward strip skidding) (Akay *et al.*, 2004; Zecic *et al.*, 2006). Loading volume has significant correlation with skidding time in every time (Egan and Baumgas, 2003). Nowadays, using of skidders

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in upward slope is increasing (Grammel, 1995; Bombosch *et al.*, 2003). Skidders are able to skidding without using of chain in slopes more 30% (without damage to forest soil) in down and upward slopes (Sarikhani, 2001). With increasing of slope, machine movement has lower speed and increase skidding time (Naghdi and Sobhani, 2001; Akay *et al.*, 2004).

In Iran country, loading volume in ground skidding almost 3 m³ with timberjack skidding 450C. Pay attention to, skidder 450C power, it is possible for downward skidding with higher volumes. Thus, purpose of this research was comparison of skidder timberjack 450C movement speed with loading differences volume on skidding time (speed of loaded traveling) in different slope classes. Furthermore, loading volume is effective on some of skidding components of winching level, loaded traveling and loading. In this research had investigated the effect of loading volume on loaded traveling component, alone.

MATERIAL AND METHODS

Study area: Area of Iran forests is 12 m ha that 1.9 m ha is located in southern of Caspian and 1.3 m ha of this area has merchant value. This forest has divided to 103 catchments area. Study area is situated in 36 of Kazemrod catchments area, the second district of Langa management plan forest and parcel 11. This district is located between 51°1′, 51°6′ longitude and between 36°30′, 36°38′ latitude. The maximum elevation is 2500 m and the mean elevation is 1650 m. The dominant aspects are northeast and west. Bedrock is sandstone with silting and argillite and lime stone. Permeable of soil is between mean and weak. Soil type is forest brown with low acidity; soil texture is heavy, relatively. The dominant forest type is Faguetum with mixed types of Alder and Maple. Forest management and silviculture methods are even aged high forest with shelter wood cutting. By these explanations, Langa region (parcel 11) was selected for this research. This research was performed in the summer of 2006.

Data collection: One of strip roads was selected in this parcel 11. In order to investigation slope and loading volume effects on skidding time should be compare time study skidder timberjack 450C with fixed slope classes in different loading volume and fixed loading volume. Therefore, we need to slope classes with equal condition. By this purpose, five slope classes (21-24, 24-27, 27-30, 30-33 and 33-36%) were determined with lengths more than 50 m on the selected strip road (Fig. 1).
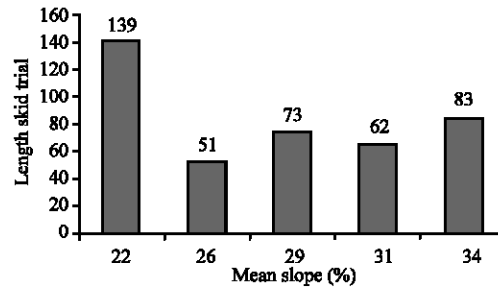

Fig. 1: Characteristics of selected slope classes

Investigations showed that loading volume is between 3.80-10.40 m³ in each time of skidding. Reason of high loading volume in each time of skidding were few suitable days for activity (hundred days in year), shuttle skidding (using of crawler and Timber jack 450C skidder for collection and transportation, respectively) and downward slope of strip road. On the basis, three volume classes (3.80-6.00, 6.01-8.20 and 8.21-10.40 m³) have selected. Pay attention to existence of five slope classes and three volume classes and the least of sample size have performed twelve time study in every of slope classes that time study was used in four time of skidding.

Slope classes determined by using of clinometers and meters in study area. Then, movement time with loading in every of classes was noted by using of chronometers stop watch and had measured length and mean diameter of logs in decking situation, in skidding season. In collection of data, have deleted all data that were with delay (exceptional of technical delays), were not logs with similar kinds and or the number of logs were not three in each skidding time. For determine of logs volume and loading volume was used of Huber's formula (1) and collection of logs volume in each time of skidding, respectively.

$$V = gm.L \qquad (1)$$

Where:
V = Log volume.
gm = Mean of log basal area.
L = Log length.

Because of, obtained data of time study haven't equal value (due to different length of strip roads in every of slope classes) therefore, was performed equalization of data and all of data converted to uniform unit of m sec⁻¹. Really, speed of skidder movement was calculated with using of formula (2).

$$V = L\,T^{-1} \qquad (2)$$

Where:

V = Speed of skidder movement (m sec⁻¹).
L = Strip road length in every slope classes (m).
T = Consumed time (sec).

The first, collection of data was converted to uniform unit of m sec⁻¹. Descriptive statistics for each data set were calculated using the SPSS software.

RESULTS

By presupposition that changes of loading volume are effective on obtained time, therefore, have investigated this parameter. Converted data have interred in SPSS statistic program. Afterwards confirm standard of data have used of variances unifying test. With ANOVA (Table 1) and comparison means of loaded traveling speed by using of Tukey test have investigated the influence loading volume. Table 2 shows that loading volume classes have not any significant influence on loaded traveling time. Also, grouping of volume classes with Tukey test have showed that three volume classes are in one group and loading volume haven't any significant influence on loaded traveling time with using of 95% confidential interval (Table 3).

Pay attention to, data collection were not unify, thus, have used of non-parametric test and with using of Kruskal-Wallis don't unify of loaded traveling time in slope classes were justify and then with using of Mann-Whitney test, mean speed of loaded traveling were compare each other in slope classes (Samadi *et al.*, 2004). Result of analysis had showed that in slope classes below 30%, slope factor haven't any significant effect on loaded traveling speed. But, in slope classes more than 30% has significant effect on loaded traveling speed and increases time of loaded traveling (Table 4). Result grouping of slope classes with using of Mann-Whitney had showed that slope classes 24-27, 24-27 and 27-30% are in first group, 30-33, 33-36% slope classes are in second and third groups, respectively (Table 5).

Table 1: ANOVA for loading volume factor

Variable factor (time)	SS	df	MS	f	Pr>f
Between groups	0.726	2	0.363	1.804	0.174
Within groups	11.463	57	0.201		
Total	12.189	59			

Table 2: Comparison groups of volume classes with using of Tukey test

Volume (I)	Volume (J)	Mean difference (I-J)	Standard error	Pr>f
3.8-6.00	6.01-8.20	0.2420	0.14181	0.212
	8.21-10.40	0.2238	0.14181	0.264
6.01-8.20	3.80-6.00	-0.2420	0.14181	0.212
	8.21-10.40	-0.0185	0.14181	0.991
8.21-10.40	3.80-6.00	-0.2235	0.14181	0.264
	6.01-8.20	0.0185	0.14181	0.991

Table 3: Grouping volume classes with using of Tukey test

		Groups for α = 0.05
Volume classes	N	1
6.01-8.20	20	3.0725
8.21-10.40	20	3.0910
3.80-6.00	20	3.3145

Table 4: Comparison slope classes with using of Mann-Whitney test

Slope classes (%)	21-24%	24-27%	27-30%	30-33%	33-36%
21-24	-	0.551	0.101	0.000	0.000
24-27	-	-	0.514	0.001	0.000
27-30	-	-	-	0.028	0.000
30-33	-	-	-	-	0.000
33-36	-	-	-	-	-

Table 5: Grouping slope classes with using of Mann-Whitney test

Slope classes (%)	N	Groups for α = 0.05		
		1	2	3
33-36	12	-	-	2.50
30-33	12	-	3.01	-
27-30	12	3.31	-	-
24-27	12	3.45	-	-
21-24	12	3.53	-	-

DISCUSSION

Analysis of data have showed that loading volume factor have not significant influence on the movement time with loading that its reason can due to high power of Timberjack 450C skidder (high maximum skidable loading volume), downward skidding and increase of speed due to produce downward high power (by reason of high loading volume in direction of machine movement). Egan and Baumgas (2003) have explained that correlation loading volume in each time of skidding with skidding time is significant.

Naghdi and Sobhani (2001) mentioned that loading volume factor is effective on skidding time. Jourgholami (2005) have introduced that loading volume is effective on skidding time, also. This research showed that loading volume factor is not effective on skidding time (loaded traveling). It is possible that reason of different result with previous researches (Naghdi and Sobhani, 2001; Egan and Baumgas, 2003; Jourgholami, 2005) is due to that previous researches had investigated influence of loading volume on the skidding components such as Winching, loaded traveling and deck, but this research have investigated influence of loading volume on the loaded traveling, alone.

Akay *et al.* (2004) had investigated efficiency of mechanized utilization machines operation and had resulted that loading volume is effect factor on skidding time in upward strip roads; furthermore, speed of machine movement in sloped grounds is lower. Their research has confirmed decrease skidding speed movement in sloped strip roads, also.
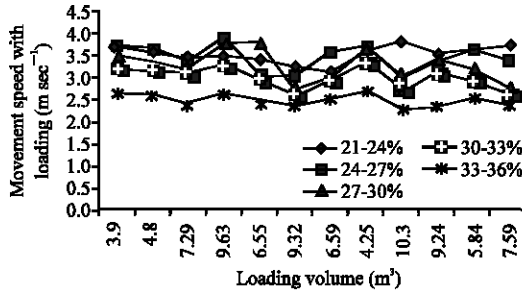
Fig. 2: Correlation of loaded traveling time and loading volume with using of Timber jack 450C skidder

Lotfalian (2001) have showed that length of strip road factor is effective on long time of movement, alone and skidding components such as loading volume, the number of logs in each time and strip road slope haven't significant influence on loaded traveling time in downward. Presence research has confirmed no influence of loading volume on loaded traveling time in downward skidding. Trzeniowski (1978) had obtained similar result, also.

Figure 2 Indicates with increase of loading volume have decreased speed of skidder movement in every slope classes. But this decrease hasn't showed with using statistic analysis. With comparison of movement speed in different slope classes will see that with increase of slope, loaded traveling speed have decreased in slope lower classes than 30%, the influence of slope on loaded traveling speed is not sensible where as in slope upper classes than 30%, the influence of slope on loaded traveling speed is sensible (Fig. 2).

Furthermore, data in slope classes of 33-66% are monotonous where as data in lower classes are not monotonous. That its reason is due to influence of environment factors on operator. Operator has more centralization for control of skidder in high slope where as in low slopes has not sufficient centralization for control of skidder.

Abeli (1996) had mentioned type, size of machine, operator expertise and region natural slope are effective factors. His research has showed operator expertise and natural slope strip road are effective factors on speed of skidder timberjack 450C movement. This research have showed that with using of Timber jack 450C skidder loading volume factor has not significant influence on movement speed of skidder in downward skidding in loaded traveling component.

Of course, loading volume is effective in maximum of skidder power on loaded traveling time in little slope in downward transition. The other researches have showed that complete loading do not existence for one time of skidding in Iran country, at all. That its reason is do not using of chocker, shuttle skidding, forest management and silviculture methods (uneven aged high stands with selection cutting) and unaware many of managers, owners of crawler machines with defects of no complete loading in one time of skidding.

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