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A Study on the Application of an Environment Friendly Crossing Wood Drain for Easy Forest Road Management

Sung-Gie Lee, Kab-Yeon Lee, Jong-Han Kim, Young-Je Kang and Kwang-Ok Byun

Warm-temperate Forest Research Center, Korea Forest Research Institute, Seogipo 697-050, Korea

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We introduce a simplified crossing wood drain disperses rain water concentration and is used to protect the road surface from erosion due to flooding over the unpaved road. The efficiency of a simplified crossing wood drain was also investigated. A structure of simplified crossing wood drain can be produced within 10 minutes and installed within 18 minutes. The cost of the this product is 1/5 of that of the existing crossing drain product. The production and installation cost can be reduced according to dexterity. In the context of such applications, the degrees of damage for a rubber pad, which preventing the rain overflow, were varied according to their materials. A type of 8.2㎜ thick fabric rubber was the most suitable in this study.

Key Words : Gravel load, Erosion of road surface, Timber, Rubber board

1. Introduction

A low level road was built to easily manage the forest by considering topography of mountain regions and working style[1], Road surface erosion occurred at exposed ground due to concentrated heavy rainfall[2,3]. In addition, there was loss of fine soil[4] according to certain problems in the road surface due to a slip caused by vehicles.

In particular, erosion of the surface of an unpaved load affect the management of mountain regions and water quality of downstream flow due to the fine soil washed out. Thus, it is necessary to control these factors[5]. Some methods are used to protect this road erosion[6]. Specific distance between drains[7,8] according to the amount of rainfall in that region, the gradient of the road, and installation distance between drains[9] are proposed. It is emphasized that a proper distance between crossing drains is an important factor for proper management of the forest[10].

From the results mentioned above, the installation distance between drains is introduced by one place with the intervals of approximately 60m and 35m for the gradient of about 5% and 10%, respectively, in Japan[7,8], even though the installation conditions were different according to specific geological features, rainfall, gradient, and other various environments. The installation distance and gradient were limited by 50m and less than 5%, respectively, at the soil of weathered rock[11]. The unpaved road and crossing drain had a closed relationship as described before. There are some reports proposing low cost structure[6,12~14] even though the installation of proper distanced drain proposed in previous studies were highly costed.

The previous studies have been conducted in priority of the necessity of crossing drains and investigation of the installable structure. However, the actual application on the field is rare because of the cost. Thus investigations of several proposed methods for protecting road surface and examinations of certain number of proper methods to deal with flowing water on the road surface were conducted. In this study investigations of the possibility of a simplified crossing wood drain application on a field for protecting the road surface from erosion and managing relevant structures were also conducted.

2. Materials and Methods

The concept of surface water leading by rubber plate was planed. Rubber plate was fixed and jutted out between wood materials obtained from thin out of mountain

Corresponding Author : Sung-Gie Lee, Warm-temperate Forest Research Center, Korea Forest Research Institute, Seogipo 697-050, Korea
Phone: +82-64-730-7232
E-mail: sulee0606@yahoo.co.kr

forest.

Wood drain catch are composed of wood for support, wall for blocking running water, and connecting nails for fixing these materials. Blocking walls were 5 different materials varied their thickness and types. The time and cost of production and installation of wood drain catch were compared to conventional drain catch structures. Forest road at seed orchard in Wontong district, Chungju was selected for this study. This area has same soil, similar slope, and is possible to measure the area.

The erosion state was also investigated before installing structures. And this area was leveled. Different wood drain catches were installed on same slope section. Survey of the change of road surface and wood drain catch was carried out. Experimental site at Wontong has both slow and quick slopes, so it was adequate for this experiment(Fig. 1).

In this site, the survey of leached soils was also conducted on September, 2003. The leached soils were filtered by a sieve and classified by dry weights. The performance test of the 5 materials set up 3~5 replications on November, 2003 were carried out once a month untie February, 2005.

3. Results and Discussion

3.1 Characteristics of forest road structure

Forest roads constructed in Korea were morphologically similar and the forest road used in this study considered as ordinary forest road. Proper standard was established for wood drain catch by route survey(Fig. 1 and Fig. 2). Slopes of road in this study were from flat to quick as maximum 21%. Road width was average 4.49m ranged from 4.0 to 5.5m. Effective road width for generally used for vehicle pass was average 2.39m ranged from 2.0 to 2.8m. Therefore 47% of road width constructed was effectively used.

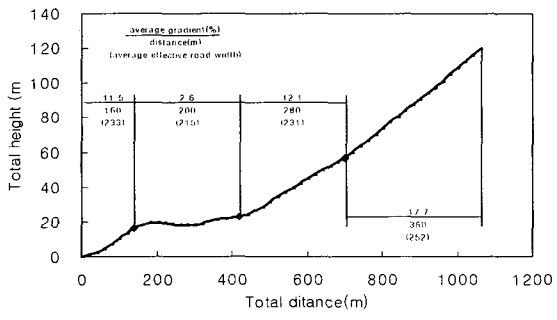

Fig. 1. Situation of the field.

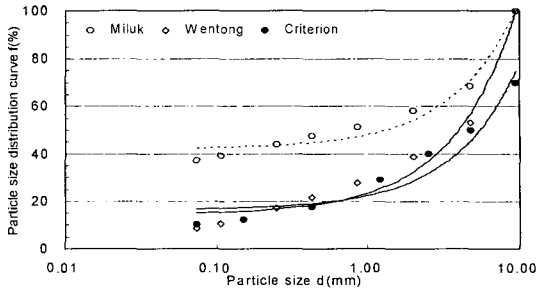

Fig. 2. Particle size distribution of the investigation field.

Particle composition of the so called suspended load was less than 74㎛, Soil particle composition percentage which affect on road base support and surface erosion was 8.41%. It was generally used as standard surface materials for gravel road. Those of unpaved road at Miruk district were 37.12%, and it was so weak to road base.

3.2 The problem of existing wood catch drain

General drain catches used in unpaved forest road including gravel load for treating surface running water were surveyed. It is advantageous to be paved with asphalt. However pavement of main management road on seed orchard have to be considered to decide utility value of road, cost for pavement, and importance of value reaching ecosystem around.

Low standard road is relatively low in utilization and is created highly. Therefore whole pavement for road utilization in short period is difficult and generally road management is commonly achieved by surface running water.

Among low standard road, which is two to three meter in width, concrete products are considered to long lasting for surface running water treatment. However it is highly costed and could be constructed only by experts. It also needs to remove steel grating for management. Therefore it is concluded to ineffective on utilization. Log weaving or unevenly pavement is relatively easy to construct and manage, but it obstructs traffic. It may be easily buried by earth and sand by overflow of small rainfall.

3.3. Characteristics of wood drain catch production and installation

A wood drain catch is composed of two woods, blocking wall, and fixing nails. Manufacture standard was 3.6m, which is enough for average effective road width 239cm and considering general thin out wood length. They are produced by own manpower. It took average 10

Table 1. Materials per place for a crossing drain

Classification	Venturi flume tube crossing drain			Wood crain
	Steel grating	Venturi flume tube	Total	
Specification(㎜)	(400×30×995)×4	(400×350×2,000)×2	-	190×180×3,600
Weight(kg)	22.2×4	344×2	865.6	30
Unit price*	-	-	100.0	16.68

notes : * represents the venturi flume tube versus steel grating, not included transportation costs.

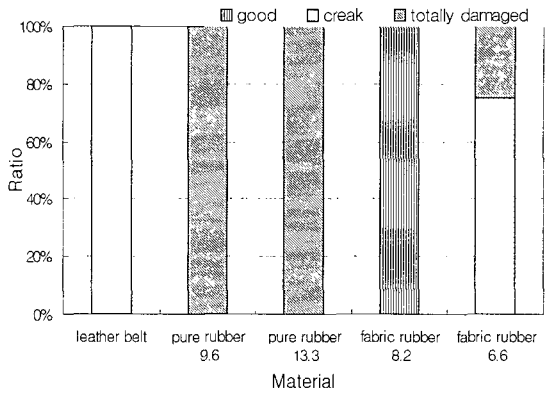

Fig. 3. Isolation material after 12 months passed.

minutes for production by 4 people. Rubber plate was exposed 5 to 10cm above the ground level for prevent flowing of sand and earth.

Installation including dig and fill in took 18 minutes per each by 4 people. Average age of worker was 64 ranged from 51 to 71 years old. Production and installation of wood drain catch for experiment was accomplished by own manpower. Therefore it could be shortened according to workers' experience.

Installation of venturi flume pipe needed backhoe and three experts (average age of 53) and took 25 minutes. It needed some period of cement work and cure. Therefore general forest roads, average width of 4.49m, have some problems for continuous installation such as cement work and restriction of heavy equipment pass. Table 1 shows the difference of weight and cost of two systems.

3.4. Characteristics of utilization of wood drain catch

For selecting proper material for blocking surface running water at wood drain catch, industrial belt, two pure industrial rubber plates, and two cloth-rubber containing fiber were purchased and installed in November 2003. This experiment was replicated four times. Damages were surveyed in certain period.

Twelve month after installation, belts were all cracked due to pass of vehicle. Ordinary rubber plates were totally broken due to pass of vehicle during winter. However, the fabric rubber, which has a single layer, used in this study is damaged after about 1.5 months from its installation, due to passage vehicles at a rate of 200 times. The fabric rubber, which has a triple layer, has presented a specific function up to this point, and an investigation for this material continuous at the present time.

4. Conclusions

Investigations of the possibility of applications of a simplified crossing wood drain, which distributes the concentration of rain flood, to protect the road surface from erosion due to rain flood in an unpaved road were carried out. As a result, a structure using this simplified crossing wood could be produced within 10 minutes per each product, and the installation could be completed within 18 minutes. The cost of the product is as low as 1/5 of that, currently used product for the construction of crossing drain. The production and installation cost could be reduced according to the degree of dexterity, too.

However in the context of such applications, the degrees of damage for a rubber pad, which prevents the overflow of rain flood, were varied according to their materials. Although, a type of fabric rubber 8.2㎜ thick was suitable in this study, it is necessary to carry out more investigations for further practical applications. The support strength of a Japanese cedar and *Chamaecyparis obtusa* is expected to sustain for more than 10 years, following the study of Umeda[18].

References

1) Lee, S. G., K. S. R. Oohashi and K. I. Kanzaki, 2001, Forest management and Forest-roads, Doosol Inc., 191pp(in Korean).
2) Packer, P. E. and G. F. Christensen, 1964, Guides for controlling sediment from secondary logging roads. Intermountain Forest and Range Expt. Sta. and Northern Region, U.S. forest Service.

3) Kochenderfer, J. N., 1970, Erosion Control on Logging Roads in the Appalachians, U.S.D.A. Forest Service Research Paper.
4) Hurutani, S. R., K. I. Kondo and Y. H. Yamamoto, 1991, On the setting conditions of water bars on the forest roads, Transactions of the Japanese Forestry Society, 102:653-654(in Japanese).
5) Lee, S. G., 1997, Study on characteristic wash-load running of from forest road surface, Tokyo University of Agriculture and Technology thesis for a doctoraldoctoral degree(in Japanese).
6) JFRS, 1997, Forest technology Standard and commentary of Forest technology direction, JFRS, pp.28-43(in Japanese).
7) Minemastu, H. H. and Y. Minamikata, 1982, The optimum-spacing of open-top culverts across the forest road, Journal of the Japanese Forestry Society, 64(5):193-197(in Japanese).
8) Minemastu, H. H., Y. Minamikata, K. H. Nishio, K. Y. ITou and K. H. Kanda, 1983, The area of application of the optimum spacing formula to open top culvert on forest roads, Journal of the Japanese Forestry Society, 65(12):465-470(in Japanese).
9) Suzuki, Y. S., T. R. Sakai and S. R. Hurutani, 1991, Estimate of forest road surface erosion(preliminary report) -From the results of continuous investigation over about 10 years-, Transactions of the Japanese Forestry Society, 102:651-652(in Japanese).
10) Hurutani, S. R., Y. H. Teki, K. I. Kanzaki and Y. S. Suzuki, 1988, On the slippage of 4WD car in running on the steep raod in the forest, Transactions of the Japanese Forestry Society, 99:693-694(in Japanese).
11) Sakai, T. R., I. Sasaki, Y. O. Huzii and S. R. Hurutani, 1982, Study on the erosion of forest road surface(1)-distance between cross drain ditches-, Transactions of the Japanese Forestry Society, 93: 539-540(in Japanese).
12) Lee, K. Y., S. G. Lee, S. D. Huer and J. H. Kim, 2004, Study on the economical maintenance of forest roads in seed orchards, Proceedings of the 2004 Annual Meeting of the KFS, 352-354(in Korean).
13) Kim, K. W., C. Y. Kim and H. S. Lee, 2004, The comparison of characteristics and construction cost of three crossing drainages, Proceedings of the 2004 Summer Meeting of the KFS, 321-324(in Korean).
14) Lee, H. S., K. W. Kim and C. Y. Kim, 2004, A study on the surface cross drain in forest road, Proceedings of the 2004 Summer Meeting of the KFS, 325-327(in Korean).
15) Juong, I. J. and B. M. Kim, 1993, soil mechanics, Moonundang., Inc., pp312(in Korean).
16) Uchida, I. R., 1987, Road engineering, Morikita, Inc., 312pp(in Japanese).
17) SFRC, 2002, Seed orchard management study meeting, KFRI., SFRC Seed orchard management study materials(in Korean).
18) Umeda, S. J., H. S. Hayashi, K. I. Morida and M. K. Yoshida, 1992, Investigation on the decay of wood retaining wall(1) -By using Pilodyn wood tester-, Transactions of the Japanese Forestry Society, 103:605-606(in Japanese).