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INVESTIGATION OF DRAINAGE STRUCTURE OF FOREST ROADS IN NORTH OF IRAN

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ABSTRACT
The Standard Drainage system is one of the most important technical buildings in the forest road construction. In this study, the effective factors on road drainage such as road width, cross and longitudinal slopes of road, slope of excavation and embankment ranges, longitudinal slope of ditch and basal area of ditch were measured in each 40 meters of 1.5 kilometer of forest road length in Darabkola forests. Then the sample point's locations were recoded using GPS (Global Position System). The Culverts diameter and the Culverts distance of each other was measured in the current Drainage system and the Culverts location was also recorded using GPS. In addition, road route was tracked and recorded using GPS to obtain more accuracy. Finally, the Drainage system of study forest road was compared with accepted standards. Results showed that there is significant difference between the current Drainage system of Darabkola forest roads and accepted standards in some cases.

KEYWORDS: Drainage, forest road, Iran.

INTRODUCTION

Water is the biggest enemy of forest roads and most of experts believe that at least 80 percentages of erosion sediments in the forest environment are due to forest roads construction. According to obtained data of developed countries, About 25 percentages of the total costs of forest roads construction is spend for drainage system construction (Sarikhani 2005). Most of forest roads are constructed in rainy and humid areas and water is one of the most important factors in their destruction (Majnounian et al 2005). Therefore the proper drainage system for a forest road is very important and vital. The Improper drainage can be caused erosion, landslide and buoyancy in the forest roads (Sarikhani 2005). Existence of any landslide and buoyancy region in the Excavation and embankment ranges is a strong reason for improper drainage system (Anon 1995). On the other hand, the proper designing of drainage system of forest roads can reduce the maintenance costs of forest roads (Swift 1985). Based on Anon research (1995), watershed basin characteristics such as public slope percentage, public slope aspect, natural drainage situation and plant cover status of excavation and embankment ranges are very effective factors on the drainage system designing. Brinker's research results (1995) showed that the drainage culvert diameter, culverts distance from each other and their slope toward road are the most important factors in the forest roads drainage. Khalilpour Amiri (2007) evaluated the drainage situation of forest roads in Estakhrposht - Neka using GIS. His research Results showed that the current drainage system is not according to water volume and mechanical characteristics of soil in Estakhrposht - Neka. In Khalilpour Amiri's research, The cross slope of road was measured 2 to 3 percentage, the side slope of ditch was measured 1 to 1.5, the longitudinal slope of ditch was measured 2 to 3 percentage, the basal area of ditch was measured 0.5 square meters and the maximum diameter of culverts was measured 40 centimeters. Akbari Fardi (2007) evaluated the culverts proper diameter of forest roads in Nekachoob forests. His Results showed that the culverts proper diameter is 27 to 158 centimeters using curve number method. Also he concluded that distance between culverts should be 419 to 480 meters. Regarding to importance of drainage system of forest roads, the purpose of the research is evaluation of drainage system of Darabkola forest roads using GIS and comparison of current drainage system with the accepted standards so that the strengths and weaknesses points of the current drainage systems can be investigated.

MATERIALS AND METHODS

Study area

Study area forests have been located in the central part of northern margin of Alborz Mountains and low and girdle heights of basin 74 which have been established in 15 kilometers distance of sari east and 36° 23′ to 36° 33′ northern latitude and 52° 20′ to 52° 31′ eastern length. The area of the Darabkola forests is 2612 hectares. Its minimum height of sea level is160 meters and maximum height of sea level is 710 meters. There are 24 kilometers roads in the region and Road density is 9 meters per one hectare (Office of Educational and Research Forest of Department of Natural Resources of Sari, 2004).

Research method

Drainage system standards were used to evaluate the drainage system of second degree forest roads in this study. GPS, clinometers and meter were used to pick up the ground data**.** The effective factors on road drainage such as road width, cross and longitudinal slopes of road, slope of Excavation and embankment ranges, longitudinal

slope of ditch, basal area of ditch (little width, large width and depth of ditch) was measured in about 1.5 kilometer of secondary forest roads and in each 40 meters to evaluate the Drainage system of second degree of forest roads (every 40 meter was considered a station). Then was recoded sample point location using GPS (Global Position System). Culverts diameter and their distance of each other in existence Drainage system was measured. Culverts location was also recorded using GPS. Position of any landslide and buoyancy region in the Excavation and embankment ranges was also recorded using GPS.

RESULTS

Tables 1 and 2 shows comparison of the existing drainage system in secondary forest roads in Darabkola (mean of picked drainage data at each sampling point) with drainage system standards in forest roads.

TABLE 1 - Comparison of width, cross and longitudinal slope of grade 2 forest roads in Darabkola with slope standards of forest roads

Factors	Cross slope (%)		Longitudinal slope (%)	Road width (meter)	
	Maximum longitudinal slope is 8%	The longitudinal slope is 3 or 4% or less		With shoulders	Without Shoulders
Standard value	2%	4%	3 - 4% to 6%	8.5	5.5
Achieved Average in Darabkola forest road	6.14		3.72	7.94	4.9

TABLE 2 - Comparison of drainage system of grade 2 forest road in Darabkola with drainage system standards of forest roads

Factors	Longitudinal slope of ditch (%)	Side slope of ditch (%)	Sizes Of ditch (centimeter)			Culvert diameter (centimeter)	distance of between culvert (meter)
			Width of ditch floor	Depth of ditch	Average width		
Standard value	Appropriate with longitudinal slope of road (3 - 4% to 6%)	1 to 4	30	At least 35	100	100-65	50 to 70
Achieved Average in Darabkola forest road	4.02	1 to 1.31	32.24	31.86	106.13	64.44	165

Results of this study showed that Average of road width with shoulders is 7.94 m and without shoulders is 9.4 m. The average of Road longitudinal slope was measured 3.72 percent. Average the cross slope of road was measured 6.14 percent. Average the cross slope of road is the mean of cross slopes averages towards excavation range (8.32%) and embankment range (3.79%). Average of Excavation range slope was measured 26.27 % and Average of embankment range slope was measured 27.70 %. Average of Longitudinal slope of ditch was measured 4.02 %. Average of Longitudinal slope of ditch was measured 1 to 1.31. Road ditch is trapezoidal shape. Average of large side (width) of ditch was measured 73.89 centimeters and Average of little side (width) of ditch was measured 32.24 centimeters. Thus average of ditch width is 106.13 centimeters. In addition the average of ditch depth was obtained 31.86 centimeters. Average of ditch basal area was also obtained 0/16 square meters. There were eight cement culverts in sample forest road (1.5 kilometer). Average of culverts diameter was obtained 64.44 centimeters. Average of culverts distance was obtained 165 meters. Wholly, two Landslide and buoyancy regions were observed in sample forest road (1.5 kilometer).

DISCUSSION & CONCLUSION

Results of this study showed that Average of road width with shoulders is 7.94 m and without shoulders is 9.4 m. While the standard values of road width with shoulders is 8.5-9 meters and without shoulders is 5.5 meters. Thus the existing road width is lower than standard value. The road width may be decreased due to pass the time but can be said that it is accordance with the standards wholly. With attention to table 1, the average of longitudinal slope of Darabkola forest Road (3.72%) is accordance with standards value (3 to 6 percent) but it is about the minimum of standard value. Average the cross slope of road was measured 6.14 percent. The slope is average of cross slopes of excavation range (8.32%) and embankment range (3.79%). This cross slope is more than standard value of cross slope of forest road but it is suitable because of more cross slope toward excavation range (from road center toward ditch) and lack of water accumulation in road surface. In addition cross slope of forest roads should be further when longitudinal slope of forest roads is low (such as Darabkola forest roads) (Sarikhani 2005). The result is different from Khalilpour research result (2007) that he has estimated the cross slope of Estakhrposht forest roads 2 - 3 %. The reason is the suitable and exact longitudinal slope of Estakhrposht forest roads. Slope of

Excavation range (26.27 %) and embankment range (27.70 %) is suitable because of their harmony with common slope of the study area. longitudinal slope of ditch (4.02 %) is suitable because of its harmony with longitudinal slope of forest road (3.72 %), its harmony with standards (3-4 % to 6%) and lack of water accumulation in ditch according to FAO standards (2006), longitudinal slope of ditch in standard situation is 2-8% for water collection without extra sediments. Average of side slope of ditch was measured 1 to 1.31 which it should be lower because of non-cement ditch in most of Darabkola forest roads. In addition in low-slope ranges, side slope of ditch is considered lower (1 to 4). These results are different from Khalilpour research result (2007) that he has estimated the side slope of ditch 1 to 1.5 that its reason is the cement ditch in Estakhrposht forest roads.

The average of ditch width is 106.13 centimeters. Although Average of ditch width is near to standard value (100 centimeters), but it is unsuitable because of plenty changes in the ditch width in some of regions. On other hand, the average of ditch depth was obtained 31.86 centimeters that it is different from standard value (At least 35 centimeters). Average of ditch basal area was also obtained 0 / 16 square meters which it should be further. Khalilpour (2007) also believe that ditch basal area (0.5 square meters) is low in his study area because of barricade in ditch. Thus important result of these researches is that the maintenance of forest roads especially drainage building is not considered in Iran.

In the study area, there were eight cement culverts in sample forest road which seven numbers of them have 60 centimeters diameter and one of them has100 centimeters diameter with attention to table 5. The average of culverts diameter is 64.44 centimeters that it is approximately according to standard values (65-100 centimeters) (Sarikhani 2005). In addition this result has harmony with Akbari Fardi research result (2007) which has obtained culverts diameter 43-49 centimeters in his study area. Average of culverts distance has obtained 165 meters which it is far more than standard value (50-70 meters) (Sarikhani 2005). Thus more construction of culverts is essential in Darabkola forest roads. On the other hand, Akbari Fardi (2007) estimated culverts distance 419-480 meters in his study area (Nekachoob forest). Thus culverts distance in Darabkola forest roads is better than those of in Nekachoob.

Wholly, two Landslide and buoyancy regions were observed in sample forest road (1.5 kilometer). According to Anon believe (1995), existence of any landslide and buoyancy region in the Excavation and embankment ranges is a strong reason for improper drainage system. Thus drainage system of Darabkola forest roads can be evaluated in moderate level considering to low landslide and buoyancy regions in Darabkola forest. Finally, we can conclude that situation of physical characteristics and engineering of Darabkola forest roads is proper and it is according to standards of forest roads in Iran. But the results of the research showed that the current drainage system in Darabkola forest roads is different from drainage system standards in some cases. Thus the using of new drainage system and biologic constancy is essential in the region.

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