A RESEARCH ON THE DETERMINATION OF THE FOREST ROADS GROUNDBASE TYPE BY TERRESTRIAL METHODS

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Abstract: *The construction of the forest roads that are the main transportation establishment is costly and entail long-term capital investment. The majority of total construction costs focus on excavation and filling costs. Especially, in the mountainously region, the road base are generally built on the excavation side, so the excavation costs enhance the total construction costs.*
In Turkey, the construction of forest road are built by the forest road contractors, which take the construction adjudication by means of public auction. The estimated costs are stated in the adjudication agreement. On the contrary that, during the road construction, the terrestrial (geological or terramechanical) conditions cause to increase the estimated construction price. On no circumstances, a disagreement that focus on the addition price demand appears between the forest administration and road contractor.
The ground base type and soil type under ground of the road route can be predicted and calculated by the terrestrial that are the geological and geophysical methods. In this study, it was used geological and geophysical methods to determine the ground type, to expose where there are excavation difficulties, to define the best road route that is economic, functional, reliable, and environmentally friendly. It was objected that the identifying of excavation material intensity and its difficulty coefficient at the beginning of the road project process. Thus, the excavating material and cost will be reduced, the real estate of the road construction will be determined beforehand, and the deserved price will be paid to road contractors. To realize for that goals, a research was conducted on several forest road construction in Trabzon, in the Eastern Karadeniz Region of Turkey. In this paper, the conceptual framework and methodology was introduced and mentioned from the preliminary and the expected results.

1. Introduction

The forest roads are the main transportation establishment for the forest operations and the construction of which entail long-term and extensive investment. The forest roads are substantial infrastructure of forests, but their negative impacts on the environment are substantial as well. The planning and construction of the forest roads are based on economical, functional, safe, and aesthetic principles. Furthermore, the road construction decisions are directly affected from topographical, technical, environmental, social, and political factors.

The excavation and filling treatments and their costs constitute the majority of total forest road construction costs. Especially, in the mountainously region, the road base are generally built on the excavation (cut) side. For this reason, the excavation costs enhance the total construction costs. During the planning and drafting of forest roads, when the road cost factors are enumerated the most dominative factor is excavation and filling costs. This cost is a function of relation between road zero line and terrain characteristics. Therefore, the forest road route planned should be located in suite areas where excavation and fill proportion is equalized.

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2. Literature review

Experienced forest engineers determine the excavation proportion of forest road construction while they are marking zero line stakes throught road line. This treatment is named as first reconnaissance. Its results are prepared in report format and preliminary road building cost is calculated respect to these results. Afterwards, the road construction job is put out to tender to be built up it. The contractors carried out the forest road construction treatments. When the road construction activities are completed, forest engineer does again second reconnaissance. In this process, an acceptance report and road ground classification are arranged to be paid of construction price to contractors. The road ground is classified as hard rock, rock, soft rock, soil, and etc. The total road construction unit cost is a function of excavation material quantity per unit. That is, road construction costs are determined according to excavated material in construction area. The ground classification is realized by using of traditional survey method based on experiments. However, after preliminary reconnaissance, it cannot be exactly estimated what are to be faced in road ground base. For example, the slack soil lands may include hard rock mass. On the other hand, when faced to hard rock in road line, it is used dynamite, compressor or drill and other blasting equipment to pass over the rock material. This situation increase road construction costs, the road construction contractor have to request an extra price for blasting operation. Thus, the adjudication price determined by first reconnaissance could change and this result cause the conflicts between forest administration and road contractor.

It is necessary that determining of ground properties in location where the road route is flagged before the forest road construction start (Erdaş, 1997; Bayoğlu, 1997). The recognizing of road ground properties is very important in order to determine the bearing capacity of ground exposing the over load.

Although various methods to obtain sensitive information on ground type, geophysical methods to designate the ground base type can give available results. In this respect, geophysical methods can be used to specify forest road ground base.

Geophysical methods can rapidly provide cheapest terrestrial information, being used by investor and engineer in own application or drafting, by helping of many measurement carrying out in earth's surface, air (aerial photos, satellite images, and remote sensing), well logging, mine gallery or laboratory. According to physical characteristics, geophysical methods are enumerated as; Seismic method, gravity method, electric-electromagnetic method, magnetic method, thermic/thermal method, radioactive method, remote sensing method and logging geophysical method (Özçep, 2001).

In general, geophysical survey includes the application of geophysical techniques to survey petroleum, gas, water, and mineral. Gravity, magnetic, seismic, self-potential, DC resistivity, induced polarization (IP) (Figure 1a and 1b), electromagnetic induction (EM), well logging (WL), ground penetrating radar, and radioactivity methods are used as modified to solve problem respect to environmental and various engineering. The use of these methods are based on the main principle that intensity, magnetic susceptibility, electrical resistivity, and conductivity of ground base properties, which are change from one place to other (Sharma, 1997).

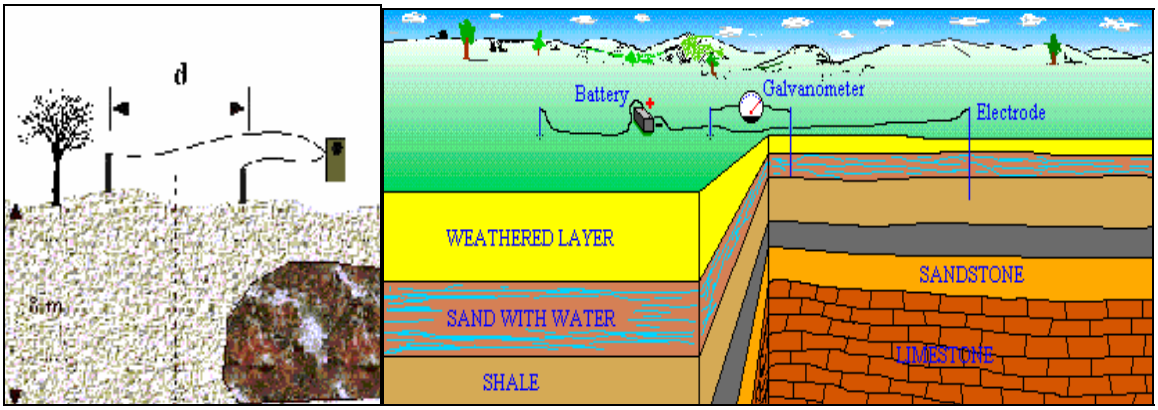

Figure 1 (a-b): Induced Polarization Method

According to a study, conducted by Washington University, the portable seismographies were used that study respect to the seismic analysis principle of shock wave spreading out in different intensity depending on ground type. Measuring of shock wave, it was determined the ground type in each zone. By using of the method, the rock formation in the road route and their deepness and resistance could be determined (Stenzel et al.,1972).

Furthermore, in Japan, the seismic waves were used to fix the excavation mass quantity in cut slope and the cost of excavation volume during a forest road construction (Winkler, 1993).

3. Problem statement

The uses of the terrestrial methods are necessary in order to be solved technical, economical, and environmental problems run into throughout forest road building. Thus, the under ground properties of forest road line can be put forward and the road layout can be changed if it is required to improve road route stability.

The forest road constructions especially at mountainously terrain have been built on cut foundation as full benched. Therefore, the construction cost focuses on soil excavation treatments. In addition that, while being excavating the road construction base, it can be faced with the hard rock formations that cannot be reckoned at first reconnaissance and at the begging of construction. This negative circumstance constitutes an extra construction cost and total construction cost increases contrary to planned costs. This is source of a conflict between forest enterprise, which is owner of road, and contractor, which is execution of road construction.

The ground base where is to be constructed a forest road has been defined by visual way without any terrestrial survey such as geophysical method. The road construction costs are planned according to first reconnaissance. The set up costs of forest road is a function of road length is to be built and excavation material quantity. But, extra costs resulted from unexpected ground difficulty, cause to grow the costs planned. For that reason, first reconnaissance done by visual way, can be misleading because the ground base type couldn't determine.

The geophysical survey may be more economical than mechanical sounding and excavation. Thus, this method may be used for forest road construction. It has been purposed to be minimized unexpected costs and environmental damages arising from unknown under ground type by using of both geophysical and geological method, which is termed as terrestrial method.

4. The methodology of geophysical survey

We justly started a project conducted by forest, geophysics, and geology engineers, topic of which is about the determination of a forest road ground base. The findings obtained from geophysical surveys are to be used a decision support system for road route and location. As we aforesaid in above, a forest road has been planned according to economic, technical, aesthetic, and functional criterion. At the same time, it is located according to topographical and land ownership situation. During the flagging of zero line to land, the technicians determine the road ground type. At this point, the geophysical survey combined with geological reconnaissance supports the decisions about where the road is located. The ground survey by geophysical method can be used for all forest road building is to be newly constructed and important road maintenance.

The use of the geophysical method starts with the application of zero line stakes to land. Throughout the zero line marked, the method is applied. The results can be integrated to geological map. This method can lead to be specified the rock formation and its resistivity in under ground at mountainously forest areas.

The geophysical survey methods to be used in forest road engineering are enumarated as below;

- DC Resistivity method (it is required resistivity and induced polarization equipment)
- Magnetic method (proton magnetometer, gradiometer (gradient of total component of earth magnetic surface))
- Seismic method (seismic refraction tools) (see Figure 2)

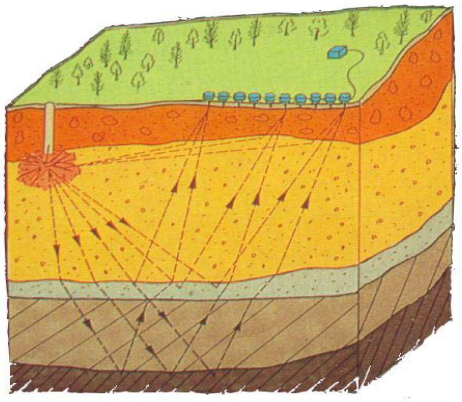

Figure 2: Image of a Seismic Reflection

These methods have preferred to solve those problems that are;

- Seismic refraction method provide information about thickness of ground layer and material type.
- If the seismic refraction is difficulty used in somewhere, then the geological material limitations can be specified by DC resistivity method revealing of ground layer depth and lateral conductivity changing.
- The hidden structural trend and base formation can be mapped out by the magnetic method in the place where is covered by the fault, cutting zone, and sedimentary material.
- The appropriateness of whichever geophysical survey method is dependent upon the physical contrast between target land and its surrounding material, dept of target land, and thickness of ground layer. Besides, regional conditions, land size, grid distance, number of measurement point, the equipment type is to be used, sensitiveness degree, penetration depth and detailed explanation are effective factor on selection of geophysical method is to used.

5. Conclusion

In the worldwide, e.g. in Turkey, the construction of forest roads have drastically continued. Until an optimal forest road network is provided, the construction process will certainly continue. For example, it was planned to be built of 10 000 km forest roan in five year period in Turkey. That is, average 1000 km forest road will be constructed in one year. On the other hand, the forest roads are costly construction and cause the damage on forest ecosystem during both building and usage process.

The geophysical survey methods can specify ground type of a forest road route. Moreover, it can produce information about; difficulty coefficient of a road building, which construction equipment is to be used, total excavation mass quantity, and total road construction cost depending on cut material volume. If a forest road route is run into heavy rock formations, which increase road construction cost, the route can be changed and the construction cost can be reduced in this way. That is, at the beginning of road construction process, excessive road construction cost may be minimized. By the way, extraordinary excavation material and its excavating treatment such as rock blasting by dynamite, which causes the damage, can be prevented in this way.

The forestlands incorporating landslides, water layer, and heavy rock zone may be determined by geophysical and geological surveys. The imperfect road route can be changed to reduce road-building cost and to suit environmentally soundly road construction techniques especially at mountainous terrain.
In the forest road building, the geological character of a forest road base can be obtained by terrestrial methods, i.e. various geophysical methods and geological survey. Thus, negative cardinal points and dangerous zones in where is located forest road line can be flagged in both forestland and map. As well, geophysical survey method can describe whether or not the ground base is available for reliable forest road construction by surveying of ground type and earthquake trends.

If it is known that the ground base is not suitable for forest road construction, thus; the conflict resulted from extra construction cost, between forest enterprise and contractors, can be removed by using of terrestrial methods.

As a result, to reduce the excessive construction costs, to minimize environmental damages, to prevent the dilemma between administration and contractor, and for other objectives, the terrestrial ground survey is required. Because, although the new planning method and tools are developed, the real situation of forest land where is to be built a forest road is very effective on road quality, construction cost, safe and aesthetics. For that reason, real ground survey results should be used as forest road database and should be added to other information file. Thus, both exact construction cost can be estimated and strong road route can be determined. Therefore, while the first reconnaissance is being done, geology and geophysics engineer should be worked and the suitable geophysical surveys should be conducted in risky areas.

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