The road's construction of Dajç – Gomsiqe on soft soil

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ABSTRACT

The purpose of this paper is the study of the construction of roads on soft soil, focusing on the road Dajc-Gomsiqe. The road is located in north of Albania in Shkodra Region. The works comprise the construction of approximately 8 km of road in generally flat and semi hilly rural areas. The scope of the construction of this road is the agricultural development and connection of the two areas - Dajc and Gomsiqe.
During the design, particular attention should be given to the fact that this road passes through an area basically with soft soil (marsh) and the difficulties this arises especially in the flood season. Since this section has experienced more than once overflows that have seriously damaged the embankment, the author of this paper will try to investigate the causes by analyzing the study conducted prior to its construction and the field conditions, in order to find possible discrepancies and offer some solution.

INTRODUCTION

This road is located on north-west of Velipoja area which is part of Shkodra region shown in Figure 1. The length of this road which consists of 8.2 km makes the connections between two areas that of Dajci (Pentare) with the other of Gomsiqe.The place where the road passes represent a hilly area of both Dajci and Gomsiqe followed by marsh field of Dajci. So, it has to be noticed that the track of this road cuts across one small hill (Gomsiqe area) to continue than in the field alongside a big drainage channel.
The road Dajc-Gomsiqe belongs to category IV (C2) in accordance with the Albanians Technical Conditions for Road Design, is designed for speeds averaging from 35 to 50 km/hour and has a width of 5.0 m (4.0 m with asphalt and two shoulders by 50 cm). This road passes through a hilly area from km 5+000 to km 8+200, while the track between km 0+000 and km 5+000 is being constructed on flat area alongside the drainage channel.
This road is being constructed in accordance with following layers:

- Sub-grade 200 mm,
- Sub-base 200 mm,
- Base layer (crushed stone material)200 mm,
- Binder course 50 mm,
- Wearing course 30 mm.

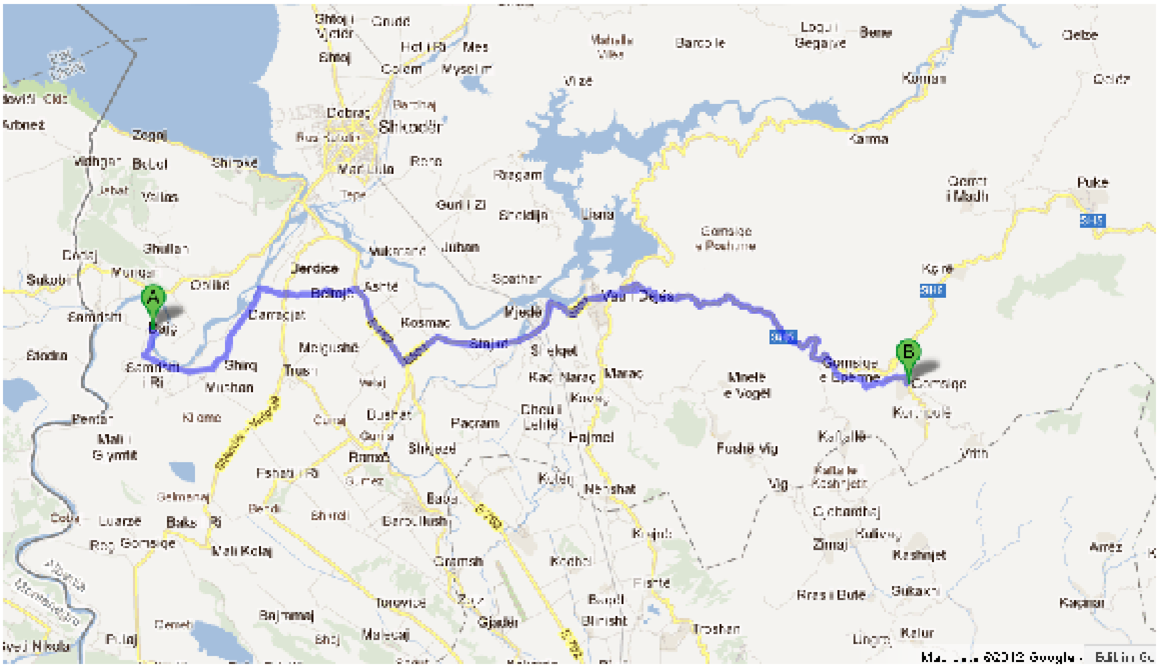


Figure1. The location of studied area

THE STUDY

For construction of roads from Dajc to Gomsiqe village is worked in several stages, which we are treating in this approach.

First stage is related to the design study: The road's design has to be based on various data such as underground water level, hydrological and geological records and the climatic factors of the whole area were this road will pass. The denomination of the category of the road determines important elements of design such as longitudinal slopes, cross section slopes, radius of turns and other. After the definition of traffic sort which is going to pass through this road, the category of the road preliminarily is determined. According with category of the road definition of longitudinal slope and minimum radius.

Second stage is geological study, Geotechnical investigation. As it has been said before, the terrain between km 0+000 and km 5+000 is flat. This field is used to a marsh and river alluviums area. What we observed in this section, the picture is that there is a combination of deposited layers of sand clay, silts sand soft clay and orphic clay.

These layers are combined with the materials deposited from the streams of area. These deposits are unconsolidated to nearly consolidate. The presence of clay and orphic clay layers prolong the time of consolidations. Substance with presence of humidity enlarges and trumpet volume of it. The layers of soft clay and orphic clay show very weak characteristics so they constitute uninformed settlements because of their heterogeneity.

Figure 2. Typical cross section of road

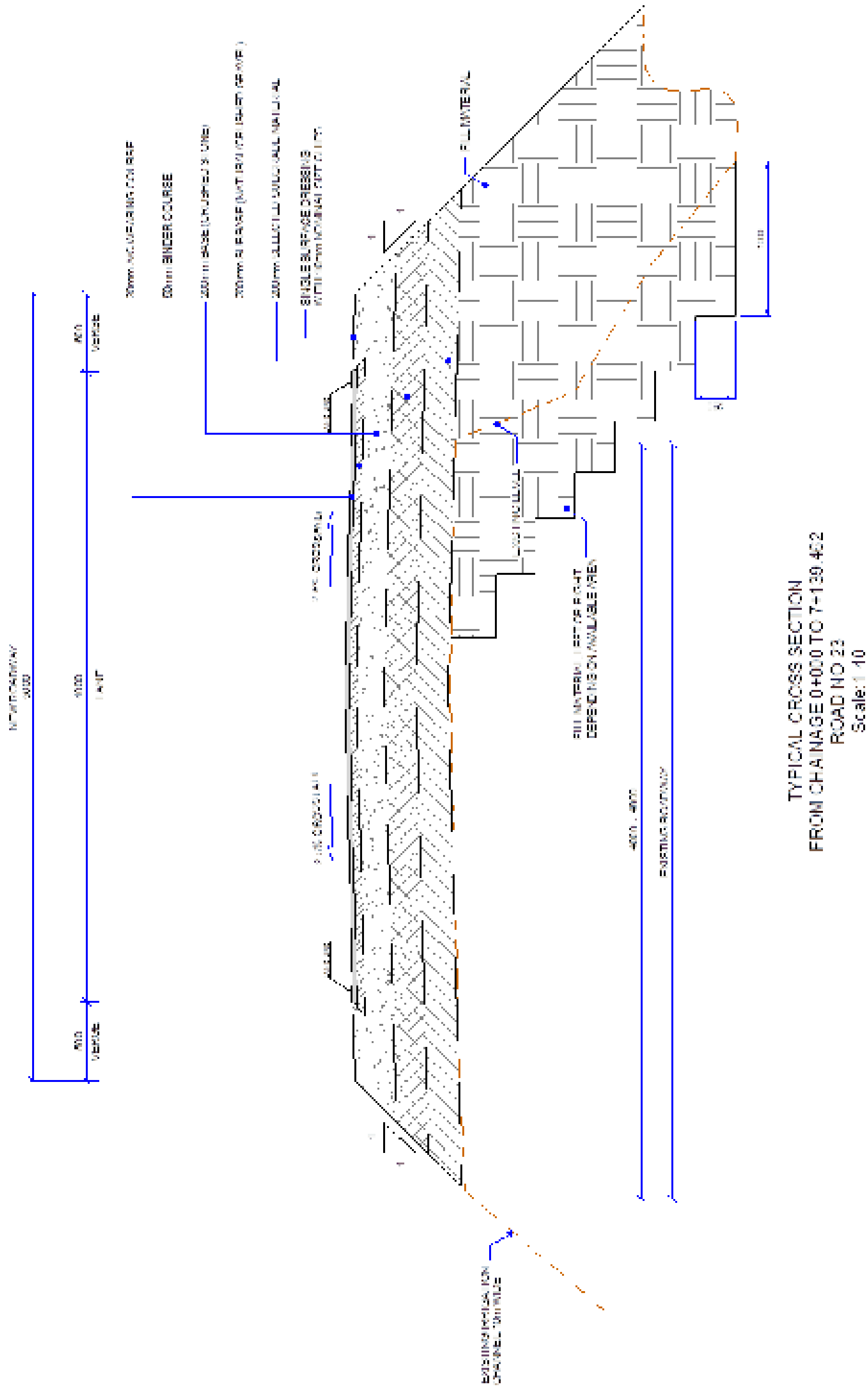
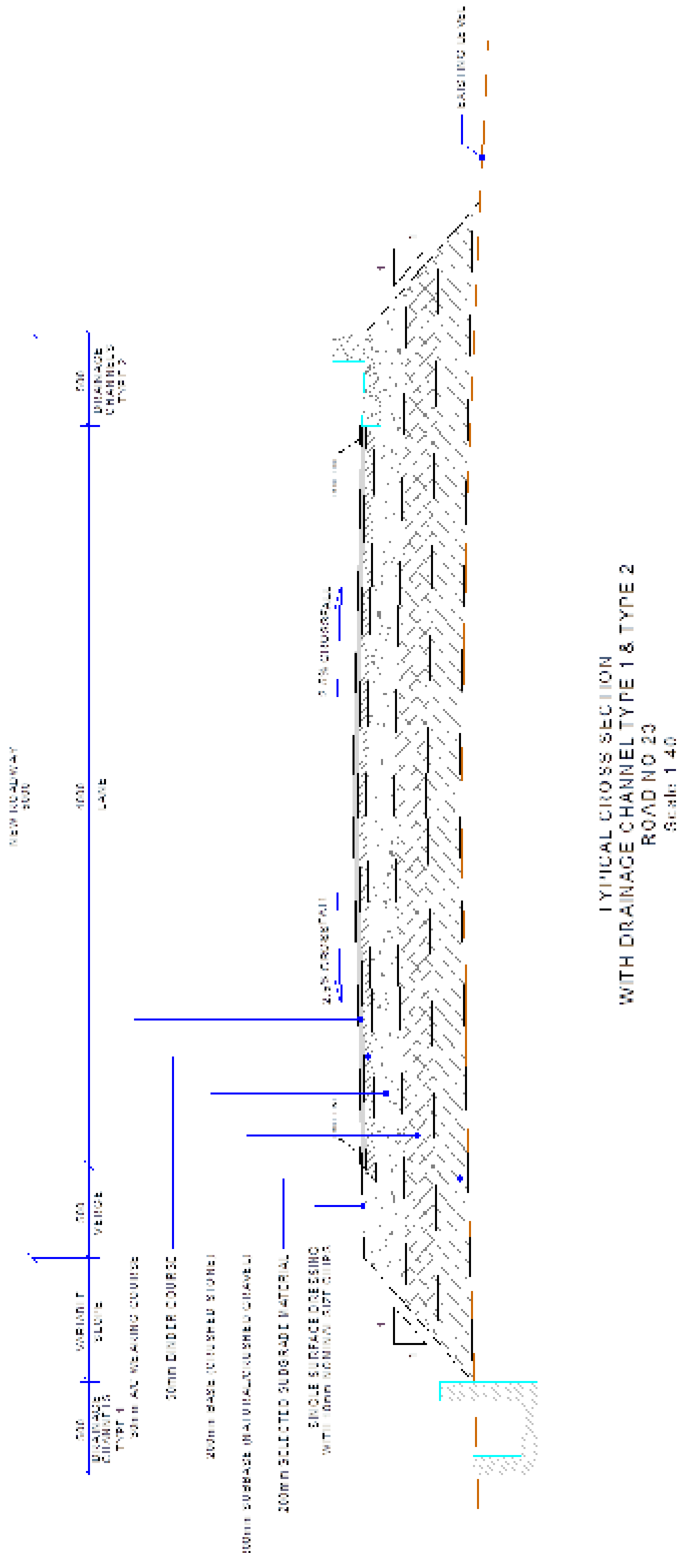


Figure 3. Typical cross section of road



We keep in mind that this area is covered by a combination of a network of drainage channels and irrigations channels. The flat area shows a damaged terrain as the result of different settles done by the moving off of undergrounds waters. As it was above mentioned, between km 5+000 and km 8+200 the road passes through hilly terrain. These hills are formed by sedimentary rocks. Sedimentary rocks are deposits fragments (clay, alevrolitet and sands). Earth structures are fragmented semi rocks and are planted with fruit-bearings trees and in some cases with vegetables, wheat and corn. So this section passes close to the hills, thus having a good foundation.

Geotechnical characteristics of construction site

The studied site is built as followings geotechnical layers:

Layer Nr.1.

Represent from top soil and silt in beige color in brown, are bit compacted. We can meet from level from 0.00 to level 0.60 m.

Layer Nr.2

Represent by silt with black color in brawn with lots of humidity and in soft condition plasticity. They are bit compacted. We can meet from level 0.60 m up to level 2.20 m.

Physical –Mechanical characteristics for this layer are:

Granular composition

Clay	< 0.002 mm	44.60 %
Silt	0.002-0.05 mm	39.80 %
Sand	> 0.05 mm	15.60 %

Plasticity

Liquid limit	W_{rr} = 44.80 %
Plastic limit	W_p = 20.60 %
Plasticity Index	Ip = 24.20
Moisture content	W_n = 34.70 %
Specific gravity	δ = 2.50 T/m^3
Unit weight	Δ = 1.76 T/m^3
Porosity coefficient	ε = 1.02
Deformation module	E = 35 kg/cm^2
Friction angle	φ = 14^o
Cohesion	C = 0.18 kg/ cm^2
Limited load	σ = 1.20 kg/cm^2
CBR test	CBR = 1-2%

Layer Nr.3

Represent by orphic clay and orphic with black color in brown. There are large quantities of humidity. They are not compacted. We can meet from level 2.20 m up to level 10.00 m. Physical –Mechanical characteristics for this layer are:

Granular composition

Clay	< 0.002 mm	46.40 %
Silt	0.002-0.05 mm	42.70 %
Sand	> 0.05 mm	10.60 %

Plasticity

Liquid limit	W_{rr} = 54.60 %

Plastic limit	W_p = 22.30 %
Plasticity Index	F = 32.30
Moisture content	W_n = 50.80 %
Specific gravity	δ = 2.40 T/m^3
Unit weight	Δ = 1.60 T/m^3
Porosity coefficient	ε = 1.22
Deformation module	E = 20 kg/cm^2
Friction angle	φ = 12^o
Cohesion	C = 0.14 kg/ cm2
Limited load	σ = 0.80 kg/cm2
CBR test	CBR = 1-2%

Third stage Hydrologic study: From the tests carried out it results that the underground waters are not aggressive to steel and concrete. The embankment of this road will be designed with the scope to provide sustainability of layers despite of the changing of water and temperatures regimen.

In order that the above scope could be met, the following measures must be taken:

- ✓ Construction of embankment with solid soil,
- ✓ Removal of unstable soil and substitutions with sustainable soil,
- ✓ Insure draining of underground and surface water,
- ✓ Construction of longitudinal and cross drains,
- ✓ Increase edge of shoulders over level of waters which have long duration, or underground water.
- ✓ Two typical cross sections shown in Figure 2 and 3.

PROJECT IMPLEMENTATION DIFFICULTIES

During the hydrological study, the tests that were carried out maintained that underground waters were not aggressive to steel and concrete, and the measures foreseen to provide sustainability to the road embankment included the removal of unstable soil and substitution with sustainable soil, drainage of underground and surface water by the construction of longitudinal and cross drains and the increasing of the edge of shoulders over level of waters. But from studies and from different measurements done in several years before in Dajci area, it results that the level of underground water in winter time and in summer time is very different. For this reason, the level of underground water is close to the surface level (-0.50 m) and in rainy days this areas are overflowed. The up mentioned measures were not sufficient to provide the necessary sustainability to the road embankment when the water reached the peak levels, causing its overflow. The pressure of the underground water caused the displacement and damage of the road embankment. This was a wide spread phenomenon, regarding approximately 5 km of the 8 km total length of the road, which reflects the gravity of the situation.

So what can be done to overcome these difficulties?

Different studies (Giroud et al. 1985; The Tensar Corporation 1996, 1998; Geosynthetic Materials Association 2000) prove that Geosynthetics can provide separation between base and subgrade materials and reinforcement of the base course and subgrade. Separation prevents the mixing of subgrade soil and granular base materials and the resulting deterioration of the base course. Reinforcement increases the bearing capacity of the subgrade, stiffens the base layer thereby reducing normal stresses and changing the magnitude and orientation of shear stresses on the subgrade in the loaded area, restricts lateral movement of the base course material and the subgrade soil, and can provide tensioned membrane support where deep rutting occurs.

The geotechnical report for this road identifies the underlying subgrade soils as medium/high plastic clays (CH). These clays are prone to swelling and shrinking with changes in moisture content and require special attention. Compaction of this soil type (CH) at moisture contents slightly in excess of optimum moisture content will also often result in reduced swelling potential. A geotextile can be recommended to be incorporated in the pavement design as this would provide separation between the subgrade and the granular sub-base material. The barrier prevents mixing of the soil and aggregate so that the drainage capabilities of the materials and the aggregate's strength are not compromised.

Surface water increasingly passes through the asphalt layers as fatigue cracking occurs with repeated traffic loads and thermal cycling. Removing water that migrates to the subgrade from these cracks will reduce swelling and differential movements of the road surface during floods and freeze-thaw cycles. AASHTO Guide for Design of Pavement Structures, 1993 states: "A drainage system can be effective in minimizing roadbed swelling if it reduces the availability of moisture for absorption". The geotextile allows for the migration of water through the geotextile from the crown of the roadway to daylight at the side slope of the road. So, the geotextile functions not only as a separator between the subgrade and granular base but as a medium to drain water away from the subgrade.

CONCLUSIONS

The road Dajc-Gomsiqe belongs to category IV (C2) in accordance with the Albanians Technical Conditions for Road Design, is designed for speeds averaging from 35 to 50 km/hour and has a width of 5.0 m (4.0 m with asphalt and two shoulders by 50 cm). This road passes through a hilly area from km 5+000 to km 8+200, while the track between km 0+000 and km 5+000 is being constructed on flat area alongside the drainage channel.
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Although the designer collected hydrological data and took in consideration the level of underground water, he did not take in consideration the peak level of underground water in rainy days. This causes flood in approximately 5 km of this road. The pressure of the underground water causes displacement and damage of the road embankment.
In this situation the use of geotextile is recommended because the layer of geotextile decreases vertical and horizontal displacement. As decreasing displacements of embankment has important role in th stability of embankment, the best place for installing geotextile layer is between the embankment base and under laying soft layer.

For this reason the embankment (subgrade and sub base) should be separated with a layer of geotextile from the under laying soft layer.

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