INFLUENCE OF SOIL TYPE ON STABILIZATION WITH MARBLE DUST FOR FOREST ROAD CONSTRUCTION

Panagiotis Ch. Eskioglou
Ass. Professor
Dept. of Forestry and Natural Environment
Aristotles University
Thessaloniki - Greece
E- mail : pxeskio @ for.auth. gr

Abstract

A laboratory study was undertaken to evaluate the effectiveness of marble dust as a soil stabilizer. The study revealed that the geotecnical parameters of forest soils are improved substantially by the addition of marble dust . Significant PI reductions occurred with MD treatment, particulary for high PI soils. Results showed that plasticity was reduced by 15 to 30% and strength increased by 25 to 50 %. The highest strength were achieved at 8 % marble dust after 28 days .Increases in the unconfined compressive strength (UCS) of soil occured with the addition of marble dust (MD). Also we found that the deflection has been reduced at 11%, CBR and the strength layer coefficient are increased 50 and 30% respectively.

Keywords:Forest road construction , Soil stabilisation, Marble dust

1. Introduction

In many instances subgrade soils that are unsatisfactory in their natural state can be altered by admixtures, by the addition of aggregate, or by proper compaction and thus made suitable for subgrade construction. In its broadest sense, soil stabilization implies improvement of soil so that it can be used for subbases, bases, and, in some rare cases, surface courses.

In Greece we have found that the clay soils (CL,CH), loam (CL , SC-CL, ML), sandy clay (SC-CL), loamy sandy (SC-CL,GC-CL),and clayloamy (CL , ML) from gabbre, peridotite, flysch and limestone are stabilized with lime , and that sandy soils (GC-CL, SC-CL), sandy loam (GC-CL , SC-CL, SM-ML), sandy clay (SC-CL), and the loam sandy (SC-CL), from granite, gneise, mica, schist and calcareous sandestone are stabilized with cement. Special research required only for the sandy loam soils. Soil stabilization with cement has resulted to : Decreasing of the plasticity less than the lime,increasing of the strength and of the angle of internal friction and of true cohesion.This increase is relatively lower in the loam soil(Eskioglou 1991).

Also we have found that with a mixture of lime (8%) and 30% flyash , we have a decrease of the maximum dry density and an increase of the moisture . With an increase of the flyash content in the soil, we have a substantial improvement of all the above mentioned factors.In gravel soils we have satisfactory results with a mixture of 9% lime and 30% flyash .(Eskioglou P. and P. Efthymiou 1996)

Another waste material is the marble dust (MD)- resulting from the quarrying and crushing of marble - and because of the fact that large volumes are produced by them annually in our country , we tried to investigate the potential of MD to stabilise soils for forest road construction. Okagbue and Onyeobi (1999) showed that the geotecnical parameters of red tropical soils are improved substantially by the addition of marble dust. Plasticity was reduced by 20 to 30% and strength and CBR increased by 30 to 46 % and 27 to 55 % respectively.The highest strength and CBR values were achieved at 8 % marble dust . Results also showed that normal 28 day curing improved the strength of the marble dust - treated soil over 80% strength gain achieved after 7 to 10 days of normal curing .Higher strength development was realised following accelerated 24 h curing at 60^{o} C.

Althought these results imply marked improvement i the geotechnical parameters of red tropical soils, the higher strength developed is not enough for the improved soil to be used as a base material in the construction of heavily trafficked flexible pavements. The improved material may,however, be successfully used as base material for lightly trafficked roads and as a sub-base material for heavily trafficked roads.

In this paper the results of soil stabilization with marble dust are presented and we expect to confirm that this represents an environmentally friendly process, as using material of nature, which is abundant and this provides the basis for improved road constructions, from the biological, technical and economical points of view.

2.Materials and method

For the purpose of this research work we have taken soil samples from the forest districts of Drama,Xanthi ,Rodopi and Evros as follows:

Applying random sampling (AASHTO - 86), we have fixed the plot points from which we have taken the soil samples.Five different soils were used for the study , and various geotechnical parameters [The particle size distribution (according to method AASHTO - T27) , the maximum dry density γd and the optimum moisture content W on the basis of the method AASHTO - T 190, Atterberg limits,standard compaction characteristics, and strength] of the soils in their natural state and when mixed with varying proportions of marble dust were determined. Each of the marble dust - treated soils was cured naturally for 28 days and strength measurements taken at 7 and 28 days, respectively, to determine the development of strength with time. Unconfined compression tests were conducted on samples molded with a Harvard miniature device.This miniature procedure was calibrated. The calibration procedure is described in ASTM Standard D 4609(ASTM). After calibration , moisture - density curves were produced using the Harvard device for each soil mixed with different amounts of dust. All samples were prepared with the same compactive effort. The results of these tests were used to evaluate the potential of marble dust as an additive in soil improvement.

Marble dust was obtained from Drama and Thassos.From these places the largest amounts of marble is obtained. The dust which utilized it was the resulting from the quarrying and crushing of marble.

3. Results and discussion

Table 1 shows the results of particle size distribution,Atterberg limits, γd and Wopt. From this we can see that the Evros soil (sample D)has the highest amount of Fines (silt or clay) 72% while the other soils have lower values .

Table 1.Results of particle size distribution,Atterberg limits, γd and Wopt.

Properties	Soil A(Evros)	B (Xanthi)	C(Rodopi)	D(Evros)	E(Drama)
Type of soil	CL	SC - CL	CL	CH	GC- CL
%< 0.075mm	83	50	92	88	45
% < 0.002mm	67	18	70	72	12
WL	40	35	35	42	28
IP	20	18	22	22	12
γd (KN/ $m3$)	17	18	17.5	16.2	18.5
Wopt.	16	14	15	20	15

The values of the plasticity index of natural soils, as well as the marble dust-treated soils are presented in Table 2.We can see that the soil with the highest clay content showed the best improvement. This is attributed partly to the initial compaction characteristics of the soil and, to the reaction between the clay minerals and the marble dust.

Table 2. Plasticity index of the natural and marble dust- treated soils

Marble dust %	PI soil A	PI soil B	PI soil C	PI soil D	PI soil E
0	20	18	22	22	12
2	19.5	17	21	20	12
4	19	16	19	18	11
6	18	16.5	18	16	10.5
8	16	16	17	15.5	10.5

Unconfined compressive strength (UCS) is showed against the percentage of (MD) and curing time in Table 3. Each data represents the average UCS from three tests.Some important observations follow:

Unconfined compressive strength (UCS) of untreated soils were in all cases lower than treated soils .For untreated soils the UCS did not increase with increasing time after molding (curing time)

Significant increases in UCS occured with increases in (MD) content in treated soils.The highest strength was achieved at 8% marble dust.

The increase in UCS due to the addition of similar amounts of MD is higher for the low PI soil relative to the higher PI soils . However , the change in UCS of treated soils as a function of percent of MD is roughly similar for each soil. For MD- treated soils, the most significant strength gains occurred after 28 days.

Table 3. Unconfined compression strength results of soil treated with 2, 4 , 6 , 8% MD after 7 and 28 days

Marble dust %	UCS soil A KPa 7 and (28)days	UCS soil B KPa 7and (28)days	UCS soil C KPa 7 and(28)days	UCS soil D KPa 7and(28)days	UCS soil E KPa 7 and(28)days
2	200 (220)	280 (330)	220 (280)	120 (180)	320 (410)
4	240 (310)	350 (420)	250 (320)	200 (250)	390 (440)
6	285 (470)	415 (500)	385 (500)	280 (400)	460 (520)
8	490 (650)	550 (650)	480 (620)	350 (540)	560 (670)

For the strength estimation we have used the Benkelman beam in experimental surface with CBR =3 and allowable deflection Dzul =175 .10^{-2} mm. We have found in the soil that : for layer thickness 20cm the Benkelman beam deflection calculated 550. 10^{-2} mm, and after the stabilisation with 8% dust,the deflection has been reduced to dm=490. 10^{-2} mm and the strength layer coefficient has been increased from a=0.1 to 0.13 like a CBR =4.5

4. Conclusions

From the above discussion of research results on soil stabilisation with the marble dust , we come to the following conclusions:

1.Plastic soils can be successfully improved after stabilization with marble dust.

2. The soil with the highest clay content showed the best improvement.

3. Significant PI reductions occurred with MD treatment, particulary for high PI soils.

4.Results showed that the geotecnical parameters of forest soils are improved substantially by the addition of marble dust.

5.Plasticity was reduced by 15 to 30% and strength increased by 25 to 50 %. The highest strength were achieved at 8 % marble dust . For MD- treated soils, the most significant strength gains occurred after 28 days.

6.The deflection has been reduced at 11%, CBR and the strength layer coefficient are increased 50 and 30% respectively.

7.The stabilization of forest roads with marble dust represents an environmentally friendly process, as using materials of nature, which are abundant and theyprovide the basis for improved road constructions, from the biological, technical and economical points of view.

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