

SLOPE STABILIZATION BY MULCHING WITH USE OF BITUMEN EMULSION AND MARBLE TREATMENT WASTE

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EXTENDED ABSTRACT

Soil erosion caused by water and wind can present a serious problem in the construction of embankments, slopes and flat areas adjacent to highways and forest roads. The most common method of combating this problem is the use of vegetation to stabilize these areas. But, during the period between the time the seeds are planted and germination takes place they are susceptible to being blown or washed away. Several procedures have been developed to protect the planting until the seeds germinate and a root system forms. One of the most effective is the use of emulsified asphalt which is sprayed directly onto the seeded area, forming a thin membrane cover. The thin film of asphalt has three beneficial effects: a. the asphalt cover holds the seeds in place and prevents their loss by the eroding forces of wind and water b. because of its dark color, the asphalt absorbs and holds solar heat during the germination period. c. The asphalt membrane tends to hold moisture in the soil , thereby promoting faster plant growth.

On the other hand there are some by-products that, instead they are rejected in the environment and him they downgrade, are searched the possibility of be used as materials that strengthen the stabilisation of slopes, decreasing with this way cost of manufacture. Such is the marble-dust which is pure CaCO_3 . There are 25 factories for treating marble dust in East Macedonia territory, produced annually more than 25000MT of waste. So, marble treatment waste use can minimize their deposits which cause huge environmental problems.

In the present research work slope stabilization was performed on the National highway Kavala-Xanthi (Xerias site) by mulching with use of simple hydroseeding (A) and a combination of hydroseeding – two kinds of bitumen emulsion (anionic and cationic ones) –marble treatment waste (B) . After two years of application, soil erosion occurred only in the area where simple hydroseeding was used whereas in the area where combination B was applied and where there was a large amount of plant covering, with no soil erosion occurred. Especially, in the case of using bitumen cationic emulsion, the amount of plant coverage was more than 60%. This kind of application results not only in slope stabilization but, in a parallel manner, in minimizing the huge environmental problem of big quantities of marble treatment waste deposits

Key words: hydroseeding, bitumen, emulsion, marble-dust

1. INTRODUCTION

Phenomena such as soil erosion which are due to big slope, big depth, various climatic conditions and soil instability are observed during the construction and use of roads and

highways [1]. In these cases, depending on the cause, many kinds of treatment are used for the protection of the environment, like :

- ✓ area modification – earth covering
- ✓ fencing e.g. by wire net or by other means
- ✓ seeding in different ways , such as in drainage basins [2],hydroseeding [3] or in combination with bitumen materials.

Treatment with seeding has an advantage, compared with technical treatment, because its performance is improved by time, its materials are not destroyed and it is very friendly to the environment. One of the most effective is the use of emulsified asphalt which is sprayed directly onto the seeded area, forming a thin membrane cover. The thin film of asphalt has three beneficial effects: a. the asphalt cover holds the seeds in place and prevents their loss by the eroding forces of wind and water b. because of its dark color, the asphalt absorbs and holds solar heat during the germination period. c. The asphalt membrane tends to hold moisture in the soil thereby promoting faster plant growth. [4,5,6].

In the present research work the materials, the method and the results refer to the treatment of slope stabilization in a national highway. This kind of treatment was done by use of hydroseeding containing a suitable mixture of seeds, fertiliser e.t.c., two kinds of bitumen emulsion (anionic and cationic ones) and marble treatment waste (in dry form).In the same location took place – in the recent past- stabilization of slope by use of hydroseeding and asphalt emulsion and the results were positive[7] .

The aim of the new research was to discover the possibility of using the wastes coming from marble treatment which are deposited in big quantities creating a huge environmental problem in area of East Macedonia. Were used marble-dust in order to prove on the one hand the durability and on the other hand the protection of environment.

2. TRIAL SITE

The Xerias site in the national highway Kavala –Xanthi was chosen as trial site, where strong phenomena of soil erosion had been observed because of bad climatic conditions and big depth of embankment. At the trial site, the mean annual rainfall is 510 mm (with two max. values in November and May), the mean daily temperature is 14° C, the average annual relative humidity is 61% and the main kind of vegetation of the area is *Quercus Coccifera*. The time of application by mulching and use of bitumen emulsion and marble treatment waste was March 2002.The slope of embankment at the trial site was more than 60% (Figure 1).

The analysis of soil of all trial site areas showed that the mining subsoil was of limestone base with a ph value 8.1, since the surface soil contained in percentage more than 30% clay with a pH value 7.7.Three areas of research were determined , with a surface of 100m² each of them , where :

- I. The treatment was done only with hydroseeding with the specific seeding mixture.
- II. The treatment was done with hydroseeding with the specific seeding mixture and the use of Bitumen Anionic Emulsion (BAE) and Marble treatment waste (MTW) in dry form (Figure 2a,b).
- III. The treatment was done with hydroseeding with the specific seeding mixture and the use of Bitumen Cationic Emulsion (BAE) and Marble treatment waste (MTW) in dry form (Figure 3).

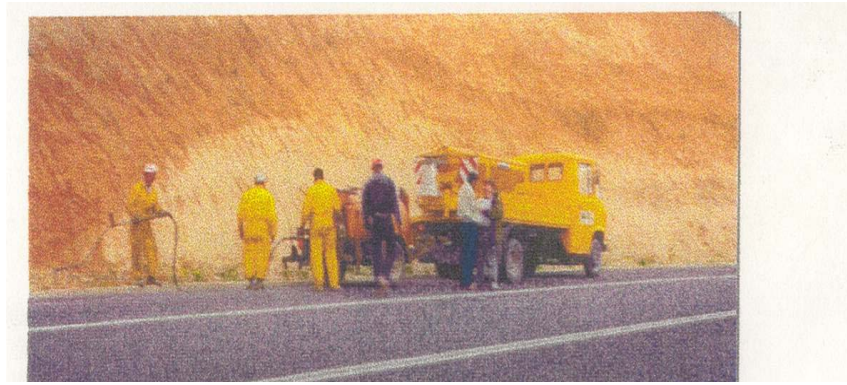


Figure 1: Preparation for stabilization in the trial site



a



b

Figure 2: Treatment with hydroseeding with the specific seeding mixture and emulsion



Figure 3: Treatment with hydroseeding and the use of Bitumen Cationic Emulsion (BAE) and Marble treatment waste (MTW)

3. MATERIALS AND METHOD OF APPLICATION

3.1. Seeding mixture

There was the choice of not using the traditional kinds of seeds, *Lolium rigidum* and *Bromus molis*, but a broadly used nowadays seeding mixture [8] for slope stabilization of Greek highways. The mixture contains: *Lolium rigidum* (15%) ,*Festuca aruddinacea* and *ovina* (28%) , *Cinodon Dactylon* (15%) , as well a mixture of *Trifolium*, *Lotus*, *Fachelia* and *Thymus* (27%) . Additionally, fertilisers, adhesive, and tyrph were used for better adhesion of the above mentioned seeding mixture.

3.2. Bitumen emulsions

Two types of bitumen emulsion were used, an anionic slow setting, BAE (SS –1, according to ASTM) [9] and a cationic slow setting, BCE (CSS-1, according to ASTM) [10].Both emulsions were produced by BITOUMINA S.A., Thessaloniki. The emulsions had the following properties (Table 1)

The use of bitumen emulsions in mulching is very old. Their energy consumption is very low, they are applied under normal conditions, they are cheap and environment friendly.

Table1: Properties of mulching bitumen emulsions

Characteristics	BAE	BCE
a. Tests on emulsion		
Viscosity , Saybolt Furol at 25° C,sec	32	28
Storage stability test , 24 h,%	<1	<1
Cement mixing sieve test, %	<2	<2
Sieve test	<0.1	<0.1
Residue by distillation, %	59	61
Particle charge test	negative	positive
b. Tests on residue from distillation test , %		
Penetration,25°C,100g,5sec,0.1 mm	>40	>40
Ductility, 25°C, 5cm/min,cm	99	98.5
Solubility in trichloroethylene, %		

3.3 Marble treatment waste

Marble treatment waste consists of marble dust (80%) and water (20%) approximately. Marble dust is pure CaCO_3 (98%). There are 25 factories for treating marble in the East Macedonia territory, producing annually more than 5.000 MT of waste. So, marble treatment waste use can minimize their deposits which cause huge environmental problems.A modified piece of equipment by a Greek company (Aktis S.A) was used for the application of the materials

At first , the mixture of hydroseeding which contained mixture of seeds, fertilisers, tyrph and adhesive was applied to all research areas (I, II ,III) . After that, bitumen emulsion and marble treatment waste (dried) were applied (II , III). The applied quantities of the materials are shown in table 2.

Table 2: Applied materials for slope stabilization (gr/m²)

MATERIALS	I	II	III
Hydroseeding mixture	50	50	50
BAE	-	500	-
BCE	-	-	500
MTW (dry)	-	-	500

4. RESULTS

After two years of application (March 2002 –March 2004), we have noticed the following results (Figure 4):

- a. Great soil erosion has occurred in area I(left side) , because only hydroseeding was applied.
- b. No soil erosion has occurred in areas II, III(right side) because of the positive combination of hydroseeding ,bitumen emulsion and marble treatment waste.
- c. Compared to the plant coverage, 60-70% with BCE was measured, since the corresponding amount of coverage with BAE was 50 –60%

The result is because BCE and MTW have different electric charge and, due to this reaction, a stronger net was created keeping the seeds more steadily in the ground.



Figure 4: Final result after 2 years. In the left side of the picture we see the part which was detached while in the right side we see the part which remained unchanged

5. CONCLUSIONS

Soil erosion caused by water and wind can present a serious problem in the construction of embankments, slopes and flat areas adjacent to highways and forest roads. One of the most effective is the use of emulsified asphalt which is sprayed directly onto the seeded area, forming a thin membrane cover. The thin film of asphalt has three beneficial effects: a. the asphalt cover holds the seeds in place and prevents their loss by the eroding forces of wind and water b. because of its dark color, the asphalt absorbs and holds solar heat during the germination period. c. The asphalt membrane tends to hold moisture in the soil, thereby promoting faster plant growth.

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