CHAPTER V

RECOMMENDATION STABILIZATION CONSTRUCTION AND COST COMPARISON

The following construction recommendations are applied to the use of lime and cement in the stabilization of subgrade, embankment, and subbase and are intended as a general guide for specification. Generally, the stabilized layer should not be worked in more than a 6 - inch lift (on a compacted basis) at a time.

Construction Procedure Outlined

The lime - cement stabilization construction can be divided into 2 stages as follow :

(1) Adding lime on soil to reduce the plasticity.

(2) Adding cement to the soil - lime mixture to increase strength and workability.

The preparation on construction of both stages can be explained as follows.

5.1 Preperation on Construction of the First Stage

5.1.1 Scarification

After the soil has been brought to line and grade on the typical sections, the subgrade (or subbase) should be scarified

to the specified depth and width of stabilization. All deleterious materials like roots, turf etc. and aggregates larger than 3 inch should be removed.

Equipment : Grader-scarifier and/or disc harrow.

5.1.2 Lime Spreading

Lime should be uniformly spread at specified percent. Dry applications encompass either spotting paper bags of lime on the roadbed or applying bulk lime from suitably equipped self-unloading trucks. To prevent wind loss and minimize lime carbonation, the lime should be covered or mixed into the soil within 6 hours after application.

Equipment : For bag application, dump or flatbed trucks are used to transport the lime to the project, and bags are spotted by hand on the roadbed. Bags are then slit and emptied into piles. Piles are leveled evenly, preferably with a drag pulled by a truck or tractor. For truck shipments, self-unloading bulk tanker trucks are most efficient for transporting and spreading Lime. Spreading can be accomplished by a mechnical spreader attached to the rear.

5.1.3 Preliminary Mixing and Watering

Preliminary mixing is required to distribute the lime uniformly throughout the soil to the proper depth and width and to pulverize the soil to minus 2 inches. During this step water should be added to raise the moisture of the soil-lime mixture to at least 5 % above optimum moisture content. After initial mixing,

the lime-treated layer should be shaped and compacted lightly prior to curing in order to minimize evaporation loss, lime carbonation, or to prevent excessive wetting from possible heavy rains.

Equipment : Single or multiple-pass rotary speed mixer, or disc harrow; water truck; and light Pneumatic roller.

5.1.4 Preliminary Curing

The lime-soil mixture should be cured for 2 days to reduce the plasticity of soil. After this step, cement will be added on the lime-soil mixture to increase the strength.

5.2 Preparation on Construction of the Second Stage

5.2.1 Scarification

The lime-soil mixture from the first stage should be scarified before adding cement.

Equipment : Same as 5.1.1

5.2.2 Cement Spreading

On mixed-in-place construction, bulk cement is spreaded on the area to be processed in required amounts by mechanical bulk cement spreaders. Bag cement is sometimes used on small jobs.

Soils that contain excessive amounts of moisture will not mix readily with cement. Clayey soils should have a moisture content below optimum when cement is spread. If the soil is excessively wet it should be aerated and dried before cement is applied.

Equipment : Cement transported truck,cement tanker with attached metering device, and mechnical cement spreader.

5.2.3 Mixing and Watering

Procedures for applying water and mixing will depend on the type of mixing machine used. Uniformity of the mix is easily checked by digging henches or series of the holes at regular intervals for the full depth of treatment and inspecting the color of the mixture. Uniform color and texture from top to bottom indicate a satisfactory mix.

Equipment : Single-shaft or multiple-shaft traveling mixing machine, windrow-type traveling mixing machine, water pump at source and water trucks.

5.2.4 Compaction

The principles governing compaction of stabilized soil are the same as those for compacting the same soil without stabilizers. The stabilized soil at optimum moisture content should be compacted to maximum density and finished immediately. Tamping rollers are generally used for initial compaction on the stabilized soil followed by a multiple wheel pneumatic roller. Medium to heavy clays require unit pressure 150 to 300 psi. Eight-inch compacted thickness is about the maximum that can be compacted satisfactorily with tamping rollers having standard length feet. If the stabilized soil is too damp, it should be acrated with a cultivator, traveling mixer, or motor grader. After it has dried to near optimum moisture, it is compacted.

Equipment : Sheepsfoot rollers and multiple wheel pneumatic rollers, motor grader or traveling mixer.

5.2.5 Curing

The compacted stabilized soil contains sufficient moisture for adequate cement hydration. The stabilized soil is cured with bituminous material, but other materials such as waterproof paper or plastic sheets, wet straw or sand are entirely satisfactory.

Cost Comparison

The cost of constructions can be estimated from the unit cost of compaction and materials per one cubic metre in the following.

Table 8 - The Costs of Stabilizers per One Cubic Metre

Stabilizers (% by weight)	Weight of stabilizers (kgs)	Cost of stabilizers (baht)
3 % cement	43.44	33.88
5 % cement	72.40	56.47
7 % cement	101.36	79.06
9 % cement	130.32	101.65
6 % lime	86.88	65.16

Note (Price in 1977)

The dry weight of soil in 1 cubic metre = 1,448 kgs.

The price of cement per kilogram = 0.78 baht

The price of lime per kilogram = 0.75 baht

Table 9 - Total Costs of Stabilized Soil per One Cubic Metre

% Stabilizers	Material Cost (baht)	Operation Cost (baht)	Compaction Cost (baht)	Total Costs (baht)
6% lime+3%cement	99.04	30	10	139.04
6% lime+5%cement	121.63	30	10	161.63
6% lime+7%cement	144.22	30	10	184.22
6% lime+9%cement	166.81	30	10	206.81

If sand were used for replacing in the existing soil instead of lime-cement stabilization :-

The cost of sand per one cubic metre loose = 85 baht

The cost of sand per one cubic metre dense = 1.4 x 85

= 119 baht

And the cost of compaction per one cubic metre = 10 baht

Therefore, the total costs per one cubic metre = 129 baht

Talbe 10 - Comparison of Cost

% Stabilizers	Average % C.B.R.	Total Costs (baht)
6 % lime + 3 % cement	12.49	139.04
6 % lime + 5 % cement	22.93	161.63
6 % lime + 7 % cement	30.46	184.22
6 % lime + 9 % cement	63.31	206.81
Construction Materials: sand	20-30	129.00

Note Data of costs supplied by Rural Road Division, Public Work Department, Bangkok, 1977.

Table 10 compares the cost of using lime and cement for the stabilization of Nong Ngoo Hao clay with that of using sand replacing in the existing soil.