BAYSTATE ROADS PROGRAM

TECH NOTES

Stabilizing Road Soil

All road construction and nearly all road improvements involve a considerable amount of earthwork. Soil is the foundation material for all roads and highways, whether it is in the form of undisturbed subgrade materials, transported and reworked base, or embankment material. Pavement loads must be transmitted to the base and subbase. If adequate support does not exist, the road will rapidly deteriorate. A good road requires a suitable foundation which in turn requires material stability.

A material is stable if it has little or no volume change and resists deformation under repeated or sustained loads whether the material is wet or dry.

The degree of stability for a satisfactorily compacted material is primarily a function of resistance to lateral flow. Because of their particle size, well keyed granular materials have a high resistance to lateral flow. Water has little effect on the internal friction (resistance to lateral flow) or volume change on these larger sized particles. However, in fine grained materials such as lays, the stability is very moisture dependent. Stabilizing materials are used to obtain and maintain desired moisture and increase the cohesion, to produce a cementing action, and to act as a waterproofing material.

Stabilizing soil mixtures lend themselves to "stage construction," which involves the gradual improvement of the road as traffic demands increase. A properly designed stabilized soil mixture might serve as a wearing surface, then receive a thin bituminous surface treatment as traffic increases, and eventually serve as a support for a high-quality pavement which will serve a heavy volume of traffic.

To select the proper stabilizing agent, an understanding is required of both the soil and agent to be used. The additive must be of the correct type and in the correct quantity to produce the satisfactory end product desired.

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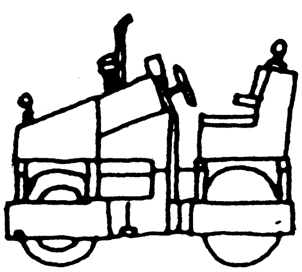

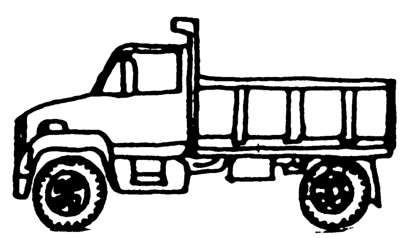

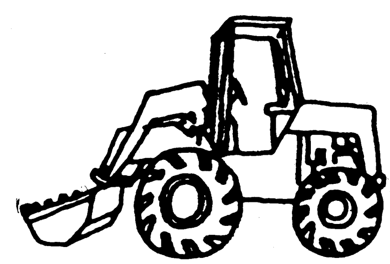

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Asphalt Stabilization

Asphalt materials are used with soils for two general purposes. They may act as a cohesive agent in sand or sandy soils or they may be used to waterproof a soil mixture. Asphalt stabilization has its greatest use in sandy soils; it finds limited use in stabilizing clay soils due to the difficulty in obtaining adequate dispersal of the asphalt.

The designation of the asphalt material to be used for stabilization is normally made by penetration grade. The most suitable grades appear to be 80-100 and 120-150 penetration. The asphalt may be mixed with the soil by specifically designed machines or it may be added to a windrow on the roadway. The soil (or sand) asphalt mixtures should be designed in the lab using some type of stability test. Usually four to six percent (4-6%) of asphalt by weight is added to the soil. After mixing the soil and asphalt, the mixture must be aerated to remove moisture and hydrocarbons. This can be accomplished by moving the windrow back and forth across the roadway using a grader. After aeration, the mixture should be spread and compacted. Compaction may be done with a sheepsfoot roller, followed by pneumatic rollers and steel-wheeler rollers. The compaction should be done in two to four inch (2-4") courses.

Calcium Chloride

Calcium Chloride is used to get maximum performance from properly graded quality aggregates; it is not used to change the characteristics of poor or questionable materials. Calcium Chloride possesses the ability to attract and retain moisture from the air. It is used to expedite the compaction process by slowing the rate of evaporation of moisture from the mixture during compactionand to aid in the retention of moisture during the service life of the soil-aggregate mixture. Small amounts of calcium chloride will, in many instances, result in in- creased density for a given compaction effort. Initial application is at the rate of approximately one-half pound per square yard, per inch of thickness.

Cement Stabilization

Cement stabilization is often referred to as soil-cement. Soil-cement is a mixture of soil, cement, and water tightly packed to high density in a moist condition. When cured, the soil-cement mixture forms a hard, rigid base course. Soil-cement may serve as a base for a thin wearing surface which will have light or medium traffic or as a support for a high-type flexible or rigid pavement. Portland cement in amounts of three to sixteen percent (3-16%) by volume of the compacted mixture is added to the natural soil. Nearly all soils may be stabilized with portland cement, but silts and heavy clays require large percentages of cement for successful stabilization.

Cement stabilization differs from other types of stabilization in that it actually hardens the soil material and structural strength is obtained from the cementing action rather than from waterproofing or cohesion. There are three fundamental control factors for soil-cement: proper moisture content, adequate compaction, and proper cement content. These should be determined by laboratory testing of representative soil samples.

Pulverized soil is mixed with the correct amount of portland cement and enough water to permit maximum compaction. Costs vary considerably.

Lime Stabilization

This type of stabilization involves the use of quicklime or hydrated lime to improve plastic clay soils. Lime is a strong alkaline base which reacts chemically with clay forming complex silicates or other cementing materials. Either high calcium or dolomitic lime can be used, but pulverized limestone is not suitable because it is relatively inert chemically. The use of lime permits the upgrading of marginal and submarginal soils into satisfactory base and subbase materials. It also improves the workability of plastic soils making them easier to pulverize. Lime tends to waterproof the soil to some extent and allows it to dry out more quickly when saturated, thus speeding construction.

Determination of the quantity of lime to use is based on lab testing. However, the amount used in subgrade treatment is generally from three to six percent (3-6%). Subgrade soil is scarified and pulverized to a depth of six inches (6") followed by spreading of lime, usually with a mechanical spreader. Enough water is added to bring the moisture content to five percent (5%) or more above optimum. The lime-soil mixture is allowed to cure for periods from one to seven (1-7) days. Mixing and pulverizing then continues until all the material will pass a one-inch sieve and sixty percent (60%) will pass a number four (4) seive. Compaction is done by pneumatic rollers or vibrator compactors. The compacted layer is allowed to cure from three to seven (3-7) days before the next layer is placed. During the curing period, it is desired to keep heavy traffic off the roadway.

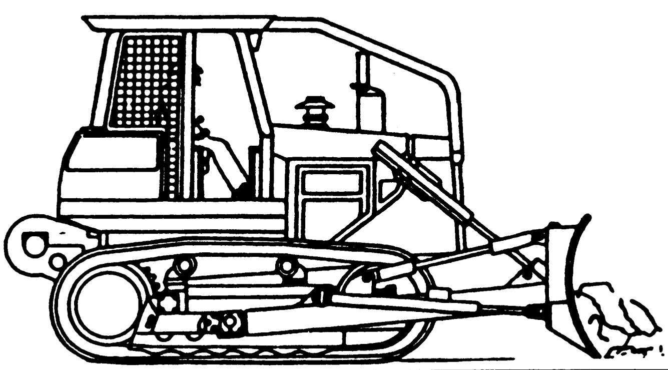
Salt Stabilization

The sodium ions present in salt stabilization react with clay particles, giving greater dispersions of some clays. This may make it possible to obtain desired compaction with less effort. It also provides a weal bond between soil particles. After curing and recrystallization of the unreacted salt within the void has taken place, a firm, stable layer is formed, increasing the strength and load bearing capacity.

Salt has considerable use in stabilizing the surface of dirt roads with low traffic volume. Salt, soil, and water are mixed: the mixture is compacted while the salt is dissolving. When the mixture dries, the recrystallized salt makes the resulting surface dense and hard. The salt binds the smaller soil particles to the larger particles "cementing" them together.

Salt may be mixed with the soil either in a pug mill or in place using a road grader. If mixed in a pug mill, 20 pounds of salt per ton of soil will suffice. (Note: one cubic yard of soil weighs about 1.5 tons.) If mixed in place, one to two pounds per square yard per inch of compacted depth should be added. Water should be added to obtain a moisture content within one to two percent (1-2%) of optimum. The salt crystals should be completely dissolved and the mixture should barely stick to equipment tires.

The mixture should be spread with a grader and rolled with a pneumatic-tired roller from the shoulder to the center of the road forming a crown sloped at one-half inch per foot (1/2" per 1') of lane width. The road surface should have a glazed look, but no moisture should appear on the surface.



Other Stabilization Materials

Other materials that have been used for stabilization are: phosphoric acid, calcium acrylate, anilinefurfural, lignins and resins, sodium silicates, surcrates, dioctadecyl demethyl ammonium chloride, aliphatic organic chemicals, lime fly ash, and many commercial products.

Summary

If economic designs of highway pavements, embankments, and subgrades are to be obtained, and subsequent maintenance costs reduced to a minimum, it is essential that the soil in these road components be brought to a satisfactory state of stability during the construction work. In many cases this can be best accomplished by the use of an additive to the soil. Because of the variety of soils encountered in nature, a sound engineering approach is required to assure successful results in any given case

Source: *Adapted for Massachusetts from the Pennsylvania Local Roads Program, Information Sheet #38, July 1989.*

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