Soil Stabilization with Emulsions

What is Soil Stabilization with Emulsions?

Soil stabilization with asphalt emulsions is the manufacture (usually in-place) of cold emulsion mixes with unclassified crushed materials, natural gravels, soils and sands.

Why Stabilize with Emulsions?

The well-known energy savings and environmental advantages of cold mix are achieved. The bearing capacity of bases or sub bases is improved at low cost using local materials. Low volume roadways may consist simply of a stabilized base sealed with a chipseal or microsurfacing. In contrast to lime stabilized bases, emulsion-stabilized bases generally do not need to be primed before overlay and do not show shrinkage cracking. Small quantities of emulsion, even as low as 1%, can give benefits in the mixing and compaction behavior of wet-bound bases, as well as in their final properties. Permeability is reduced and since the fines become to some extent encapsulated by asphalt, the water sensitivity of the materials is improved.

What Materials Can Be Stabilized with Emulsions?

A very wide variety of materials has been successfully stabilized with emulsions. Some general conclusions can be drawn from these experiences:

- Non-plastic materials with a sand equivalence of >30 and up to 15% minus 75 micron fines can be treated with good results. In the case of unclassified crusher materials, the results are similar to the result from hot mixed materials.
- Materials with a sand equivalence of 20-30, a plasticity index <8 and up to 20% minus 75 micron fines can usually be improved economically.
- Materials with a sand equivalence less than 20 or a plasticity index >8 are candidates for a combined treatment of hydraulic binder such as lime or cement and asphalt emulsion.

Design of Roadways Incorporating Stabilized Layers

CBR values on stabilized layers allow design calculations to be made. It is often economic to stabilize a sub-grade to produce a load-bearing sub-base and so limit the thickness of other structural layers. Emulsion stabilization also provides a degree of waterproofing. Emulsion stabilized layers show good resistance to shrinkage cracking. Early life failure is generally by deformation, later by fatigue. Some design methods have been developed to deal explicitly with these two stages. Early stiffness can be increased by the addition of lime or cement and combined treatments may be favored for this reason even when the soil is non-plastic.

Mix Design

Soils should first be evaluated for their plasticity index and sand equivalence values to see if they are suitable for emulsion stabilization. If the plasticity index is high, then the possibility of reducing it with lime can be investigated. Similar design procedures as used for dense-graded emulsion mixes are also applicable to stabilized materials. CBR is appropriate for lean mixes

with emulsion contents below 2%. Marshall stability or other tests used for hot mixes are suitable for higher asphalt contents.

Emulsions used in soil stabilization are generally of the CSS-1h type, but additional stability is required to cope with the presence of reactive fines. Redicote E-4868 emulsions provide the right mixing characteristics with reactive aggregates. Redicote E-4868 has been used successfully with both cement and lime in combined stabilization treatments. While CMS emulsions may be suitable for clean sands or high quality crushed aggregate, the variability inherent with in-place mixing favors the choice of a slower-setting emulsion.

Production of Emulsion-Stabilized Materials In-Place

Materials are generally stabilized on the roadbed. Any clumps need to be broken up effectively, which is best done before any water is added. Lime or cement modification is done first if required to control plastic fines. Any virgin aggregate is windrowed or spread on the road surface depending on the mixing equipment used Rotary mixers, disc harrows or blade mixers can be used. Modern equipment designed for recycling can also be used. It is important that the soil is brought to the design water content before emulsion is added. In some equipment the emulsion can be added while mixing. In blade mixing the emulsion is sprayed over the surface. The emulsion may need to be diluted before use to help distribution. In this case water is added to the emulsion, not the other way round.

The material is then mixed to the full design depth until homogeneous, although not all aggregate surfaces need be covered. Generally more than one sequence of emulsion spray, mixing, grading, partial compaction, harrowing may be required before all the emulsion is added.

Aeration may be required before final compaction. It can be achieved by moving the material with a grader or re-passing with the mixer. Additional emulsion may be added in the surface layer to act as a prime for hot overlays or to improve the water resistance of the surface before sealing.

References

1. *Dense-Graded Mixtures Using Asphalt Emulsions*, AEMA Recommended Performance Guidelines 2nd Edition, pp71-76.
2. *GEMS – The Design and Use of Granular Emulsion Mixes,* SABITA (South African Bitumen and Tar Association),Manual 14.
3. *A Basic Emulsion Manual No.19*, 3rd Edition, AEMA.