Table G.1—Nontraditional stabilizers (from FHWA Surfacing Context Sensitive Roadway Surfacing Selection Guide 2005) (continued)

ENZYMATIC EMULSIONS

GENERAL INFORMATION

Generic Name(s): Enzymatic Emulsions, Enzymes

[redacted]

Product Description: Many of the emulsions for dust suppression and/or soil stabilization are proprietary in nature and the exact composition and stabilization mechanisms are not publicly available; therefore, often it is difficult to group or classify the various emulsions accurately.

Enzymatic emulsions contain enzymes (protein molecules) that react with soil molecules to form a cementing bond that stabilizes the soil structure and reduces the soil's affinity for water. Categorically speaking, enzymatic emulsions work on a variety of soils as long as a minimum amount of clay particles are present. When applied at low application rates to the surface of the unbound road surface, enzymatic emulsions perform well for dust suppression. They bond soil particles together and so reduce dust generation. At higher application rates, enzymatic emulsions can be used to stabilize soils. When applied and compacted properly, the treated soil can be stabilized to form a dense, firm to hard, water-resistant bound layer that can be used as a road surfacing.

Most of the information available on enzymatic emulsions comes from brochures and literature provided by the manufacturer. Therefore, it may be difficult to find independent test information for a particular product. The performance and applicability of enzymatic emulsions can vary from one product to the next. In addition, products are frequently reformulated; so, historical case studies may no longer be representative of a current product. As a result, product-specific testing and/or performance verification is recommended when selecting an enzymatic emulsion.

[redacted]

Representative product suppliers and trade names are provided for informational purposes only. Inclusion of this information is not an endorsement of any product or company. Additional suppliers and enzymatic emulsion products are available.

APPLICATION

Typical Use: Dust suppressant, soil stabilizer.

Traffic Range: Very low to low (AADT < 250).

Restrictions:

Traffic: Required application frequency will increase with increased truck traffic or increased vehicle speed. Additional traffic loading restrictions may be required depending on the material being treated (e.g., the load-carrying capacity of a clay soil is typically much less than that of a granular material).

Table G.1—Nontraditional stabilizers (from FHWA Surfacing Context Sensitive Roadway Surfacing Selection Guide 2005) (continued)

Climate: None.

Weather: Enzymatic emulsion-treated surfaces can become slippery when wet, particularly with soils with high clay content (greater than 20 or 30 percent). Minor grading/reshaping and localized repair may be required after heavy rainfalls.

Terrain: None.

Soil type: Categorically speaking, enzymatic emulsions work on a variety of soils as long as a minimum amount of clay particles are present (greater than 10 percent) and the plasticity index is greater than 8. Enzymatic emulsions generally work best on soils with 12- to 24-percent clay and a plasticity index between 8 and 35. Enzymatic emulsions work best when the moisture content is 2- to 3-percent below optimum moisture content for compaction.

Other: None.

Other Comments: None.

DESIGN

SLC: N/A for dust suppression applications; typically 0.08 to 0.14 (increases with increased quality of treated material) for stabilization applications.

Other Design Values: Enzymatic emulsions can increase the soil strength by 30 to 300 percent.

Base/Subbase Requirements: Roadway should be designed with adequate base and/or subbase support.

Other Comments: The road surface should be graded to promote surface drainage and prevent ponding on the road surface that can promote softening of the treated materials.

CONSTRUCTION

Availability of Experienced Personnel: Enzymatic emulsions are not as commonly used as some other dust suppressant and soil stabilizer products, but experienced contractors are, in general, available.

Materials: Enzymatic emulsion products are typically purchased in liquid concentrate form. Water is required to dilute the enzymatic concentrate once it is delivered to the site.

Equipment: Equipment required for enzymatic emulsion application includes: tanker or water truck with spray bar, grading equipment (i.e., bulldozer or motorgrader), and roller. Equipment is widely available in most areas, but availability may be limited in remote areas.

Manufacturing/Mixing Process: Enzymatic concentrate must be mixed with water to achieve the desired concentration level prior to application. Dilution ratios of 1 part enzymatic concentrate mixed with 100 to 500 parts water are common.

Table G.1—Nontraditional stabilizers (from FHWA Surfacing Context Sensitive Roadway Surfacing Selection Guide 2005) (continued)

Placement Process: Enzymatic emulsions can be applied by a sprayed-on method or mixed-in (windrowing) method, but mixed-in method is most common. Recommended mixing depths for dust suppression and stabilization range from 25 to 50 mm (1 to 2 in) and 100 to 200 mm (4 to 8 in), respectively. The moisture content of the soil prior to treatment should be below optimum for compaction so that the soil moisture content will be below or near optimum once the enzymatic emulsion is added, considering the water provided by the emulsion; if the material is very dry or saturated, processing to achieve moisture content adjustments is recommended prior to treatment. For dust suppression applications, scarifying the surface allows the enzymatic emulsion to penetrate evenly and quickly into the road surface. For soil stabilization applications, the soil is loosened to the desired treatment depth. The enzymatic emulsion is then applied uniformly using a tanker or water truck with a spray bar and mixed with the loose soil. The enzymatic emulsion is often applied in multiple passes to get better overall mixing. Once mixed in place, the treated material is graded and compacted.

Weather Restrictions: Do not apply enzymatic emulsions if rain is likely within 24 hours or if temperatures are below 4 °C (40 °F) or 16 °C (60 °F), depending on the product used.

Construction Rate: Enzymatic emulsion construction rates are in the range of 2,000 to 5,000 m^2/day (2,400 to 6,000 yd^2/day).

Lane Closure Requirements: The roadway lane should be closed during construction, but can be opened to light traffic once construction is complete. The stabilized material should be allowed to cure for 2 to 3 days before normal traffic, including heavy loads, are allowed onto the surface.

Other Comments: The required application rate will vary based on the characteristics of the material to be treated and the degree of stabilization desired. Test sections are recommended to determine/verify the appropriate application rate.

SERVICEABILITY

Reliability and Performance History: Enzymatic emulsions are still relatively new compared to some other commonly used dust suppressant and soil stabilizer products. Limited research, design and construction information, and project experience are available. Performance can vary significantly between different products and is influenced by traffic, soil type, weather conditions, application method and rate, and contractor performance. As a result, product specific testing and/or performance verification is recommended when selecting an enzymatic emulsion.

Life Expectancy: Life expectancy varies depending on traffic and weather conditions. Typical life expectancy is 5 to 7 years for stabilization applications, with some treated surfaces still in service after 12 years or more. When an effective enzymatic emulsion product is applied in the proper situation, constructed properly, and maintained, good performance and long life expectancies are realized.

Table G.1—Nontraditional stabilizers (from FHWA Surfacing Context Sensitive Roadway Surfacing Selection Guide 2005) (continued)

Ride Quality: Ride quality depends on the treated aggregate. Ride quality deteriorates over the serviceable life. Enzymatic emulsions do not provide any improvement in ride quality; however, the rate of deterioration is less than the rate for untreated surfaces. By reducing particle loss and washboarding, surface distress is reduced and ride quality is preserved. Enzymatic emulsions can reduce aggregate loss by 50 percent or more.

Main Distress/Failure Modes: Dust, rutting, washboarding, potholes.

Preservation Needs: Periodic grading may be required, typically every year and possibly after heavy rainfalls. For dust suppression applications, grading should be performed in a manner such that the stabilized "surface crust" is not broken. For soil stabilization applications, additional sprayed-on applications may be required periodically to extend the serviceable life.

SAFETY

Hazards: Proper handling and mixing procedures should be followed when mixing the concentrated liquid with water to create an emulsion.

Skid Resistance: Enzymatic emulsion-treated materials form a firm to hard, skid resistant surface. However, the road can become slippery when wet when the surface contains high clay content (greater than 20- or 30-percent clay).

Road Striping Possible?: No.

Other Comments: Enzymatic emulsions can typically reduce road dust by a significant amount.

ENVIRONMENTAL CONCERNS

Source of Raw Materials: Enzymes are natural materials that are manufactured from natural materials or obtained as byproducts of the food processing and manufacturing industries.

Delivery and Haul Requirements: Enzymatic concentrate must be hauled to the site from the distributor. Haul distances may be significant for remote sites. Hauling requirements are reduced somewhat by the fact that the product is shipped in concentrated form and can be mixed with water at the site.

Potential Short-Term Construction Impacts: Spills or runoff during the emulsion mixing process could have a negative impact on nearby vegetation, water quality, or aquatic species.

Potential Long-Term Environmental Impacts:

Leachate: None.

Surface runoff: Enzymatic emulsion-treated soil is relatively impermeable, which promotes surface runoff. However, surface runoff water quality is not generally impacted by enzymatic emulsion treatments.

Erosion: Enzymatic emulsions reduce the erodibility of the unbound roadway surface by binding surface particles together.

Table G.1—Nontraditional stabilizers (from FHWA Surfacing Context Sensitive Roadway Surfacing Selection Guide 2005) (continued)

Water quality: None.

Aquatic species: None.

Plant quality: None.

Air quality: None.

Other: None.

Ability to Recycle/Reuse: The treated soil/aggregate can be reused in any manner similar to the untreated material.

Other Environmental Considerations: Environmental impacts of enzymatic emulsions may vary between different proprietary products; specific product information should be collected and reviewed prior to product use. Once diluted to normal application rates, enzymatic emulsions are typically biodegradable, nontoxic, nonhazardous, noncorrosive, and generally environmentally friendly.

AESTHETICS

Appearance: The addition of enzymatic emulsion does not significantly alter the appearance of a soil or aggregate road. The appearance will be of a soil/aggregate surface with the overall color determined by the soil/aggregate type and source. The treated soil/aggregate will have a slightly darker appearance than the parent material.

Appearance Degradation Over Time: Without maintenance, enzymatic emulsion-treated roads deteriorate over time in terms of surface uniformity.

COST

Supply Price: N/A

Supply+Install Price: \$2.40 to \$4.80/m^2 (\$2.00 to \$4.00/yd^2) for mixing to a depth of 150 mm (6 in.).

EXAMPLE PROJECTS

Laguna Atascosa National Wildlife Refuge, Rio Hondo, TX.

Auto Tour Roads, Buenos Aires National Wildlife Refuge, Pima County, AZ.

SELECT RESOURCES

Scholen, Douglas E. 1992. Non-Standard Stabilizers, FHWA-FLP-92-011, U.S. Department of Transportation, Washington, D.C. 113 p.

USDA Forest Service. 1999. Dust Palliative Selection and Application Guide, San Dimas Technology and Development Center. 23 p.