OHD L-50
SOIL STABILIZATION MIX DESIGN PROCEDURE

The soil stabilization mix design procedure consists of two methods. The first method consists of an abbreviated laboratory test procedure with determination of the recommended percentage of stabilization additive from the Soil Stabilization Table. The second method is the complete laboratory test procedure with determination of the recommended percentage of stabilization additive from the test results. The second method is used if a checkmark appears in the Soil Stabilization Table or if requested due to specific concerns on a project. The laboratory test procedure follows the general requirements of the ASTM D 6276, Annexes A1 and A2 of ASTM D 4609, and as described below. The stabilization additive and water used in the mix design procedure shall be from the source proposed for use on the project. Laboratories performing soil stabilization mix designs shall be qualified by the Materials Division.

A) For All Soils:

Test the sample for gradation according to AASHTO T88, liquid limit according to AASHTO T89, and plastic limit and plasticity index according to AASHTO T90. Determine the soil group classification according to Table 2 of AASHTO M145.

Test the sample for soluble sulfates according to OHD L-49. If the soluble sulfate content is greater than 500ppm, additional samples for soluble sulfate testing should taken throughout the length represented by the sample. If the soluble sulfate content is greater than 1000ppm for any of the additional samples, stabilization with calcium-based additives may not be suitable. If the soluble sulfate content is greater than 8000ppm for any of the additional samples, stabilization with calcium-based additives is not recommended.

For samples from Divisions 2, 5, and 7. Test the samples for soil dispersion using the Crumb Test, ASTM D6572. If a Grade 3 or 4 is indicated by this test procedure, further testing for soil dispersion is required. Test the soil using the Pinhole test procedure, ASTM D4647. If this test indicates a dispersive soil, notify the Resident Engineer. The mix design may proceed, but all exposed grading surfaces represented by this soil sample will require special treatment, such as 8 inches of lime or fly ash modification, to prevent erosion problems. There are recorded cases of dispersive soils occurring randomly in all field divisions. After Divisions 2, 5, and 7; the presence of dispersive soils in descending order is Division 1, 3, 4, 8, 6. For samples from these divisions; if evidence of dispersive soils is reported or observed, conduct soil dispersion testing as described above. For samples from Division 6, lime should be used with caution.

B) For Fly Ash, Cement Kiln Dust, or Portland Cement Stabilization:

Verify the stabilization additive is from an approved source. Determine the recommended percentage of stabilization additive from the table. If a checkmark appears in the table for the soil group classification and additive or if requested due to concern over a specific soil, use the mix design procedure.

The mix design procedure shall follow the general requirements of the Annexes A1 and A2 of ASTM D 4609. The curing period is five days for moisture absorption specimens and seven days for the remaining specimens.

Note: AASHTO T-99 Method A shall be ran on the material passing the No. 4 sieve. Harvard Miniature specimens are prepared using material passing the No. 10 sieve.

Three or more percentages of stabilization additive are to be tested in addition to the untreated soil. The suggested percentages for Portland Cement and cement kiln dust from pre-calciner plants are 2, 4, and 6. The suggested percentages for cement kiln dust from other type plants are 7, 9, and 11. The suggested percentages for fly ash are 6, 9, 12, and 15 percent. Other percentages may be used.

Determine the recommended percentage of stabilization additive based on the unconfined compressive strength of the specimens. Using the cured samples, select an additive percentage that gives a minimum increase of 50 psi, but no more than 150 psi, above the unconfined compressive strength of the untreated soil. Using the immersed samples, select an additive percent that gives a minimum increase of 50 psi above the unconfined compressive strength of the untreated sample. Use the higher of the two values.

C) For Lime Stabilization:

Verify the stabilization additive is from an approved source. Determine the recommended percentage of stabilization additive from the table. If a checkmark appears in the table for the soil group classification and additive or if requested due to concern over a specific soil, use the mix design procedure. The mix design procedure shall follow the requirements of ASTM D 6276 to determine a recommended percentage of lime stabilization additive.

D) Target Density and Optimum Moisture:

Determine the target density and optimum moisture content for the raw soil and the soil containing the recommended percentage of stabilization additive using AASHTO T-99 Method A, Method C, or Method D. Use Method D if the soil has more than 5% retained on the 3/4 inch sieve. Use Method A if the soil has 5% or less retained on the No. 4 sieve. Otherwise, use Method C.

E) For Lime Pretreatment:

Use the mix design procedure for lime stabilization to determine the percent required to stabilize the material. Choose a lesser percentage than the percent required for stabilization. Mix the soil with chosen percentage of lime and cure for 72 hours. Determine the group classification of the lime pretreated soil to determine if the pretreatment has changed the material properties of the soil so that it now meets an A-1 through A-6 Group Classification. If yes, follow the mix design procedure in B to determine the recommended stabilization additive percent. If not, choose a higher lime percentage and repeat.

F) The Mix Design Report shall include the following information, when applicable:

- AASHTO group classification of raw soil.
- Soluble sulfate content of soil.
- AASHTO group classification of lime pretreated soil (if applicable).
- Unconfined compressive strengths of cured specimens (if applicable).
- Unconfined compressive strengths and moisture absorption of immersed specimens (if applicable).
- Recommended percent stabilization additive and source.
- Density and optimum moisture content for raw soil.
- Density and optimum moisture content for soil containing the recommended percentage of stabilization additive.

G) Soil Stabilization Table

When using the abbreviated laboratory test procedure, the recommended amount of the stabilization additive shall be determined by the AASHTO Group Classification as detailed in the following table.

SOIL STABILIZATION TABLE

ADDITIVE (Expressed as a percentage added on oven dry basis)	**SOIL GROUP CLASSIFICATION - AASHTO M145**											
	A-1		A-2				A-3	A-4	A-5	A-6	A-7	
	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7					A-7-5	A-7-6
PORTLAND CEMENT	4	4	4	4	4	4	5	√	√	√		
FLY ASH					12	12	13	14	14	14		
CEMENT KILN DUST (Pre-Calciner Plants)	5	5	5	5	5	5	6	√	√			
CEMENT KILN DUST (Other Type Plants)	10	10	10	11	11	11	12	12	12			
HYDRATED LIME*										4	5**	5**

A blank in the table indicates the additive is not recommended for that soil group. Recommended amounts include a safety factor for loss due to wind, grading, and/or mixing. Pre-Calciner plants are identified on the Materials Division approved list for cement kiln dust.

√ = Mix Design Required

* = Reduce quantity by 20% when quick lime is used, i.e. 4% x 0.8 = 3.2%, 5% x 0.8 = 4.0%, 6% x 0.8 = 4.8%

** = Use 6% when the liquid limit is greater than 50.

Revision Date	Revision Description
10/20/06	Soil Stabilization Table revised to split Cement Kiln Dust into two types and provide recommended percentages for each type. Changed recommended percentages for most entries in the table
	In Section B, changed suggested percentages to use for laboratory mix design. Deleted higher strength requirement for portland cement. Deleted rock adjustment. Target density and optimum moisture moved to Section D.
	In Section C, deleted rock adjustment. Target density and optimum moisture moved to Section D.
	Added new Section D and renumbered remaining sections.
	In Section E, added option to choose a higher lime percentage and repeat.
07/28/09	Revised description at beginning of procedure.
	Soil Stabilization Table moved from beginning to new Section G. Revised recommended percentages for cement kiln dust and fly ash.