OHD L-50
SOIL STABILIZATION MIX DESIGN PROCEDURE

Laboratories performing soil stabilization mix designs shall be qualified by the Materials Division.

The soil stabilization mix design procedure consists of two approaches. Determination of the recommended percentage of stabilization additive from the following table. If a checkmark appears in the table or if requested due to specific concerns on a project, use the laboratory test procedure that follows the general requirements of the ASTM D 6276 or Annexes A1 and A2 of ASTM D 4609 or as described below. The stabilization additive used shall be governed by the AASHTO Group Classification as detailed in the following table reprinted from special provisions for subgrade stabilization. The stabilization additive and water used in the mix design procedure shall be from the source proposed for use on the project.

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	5	5	5	5	5	5	5	√	√	√		
FLY ASH					12	12		12	12	12		
CEMENT KILN DUST	7	7	7	7	7	7	7	7	7			
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.
√ = 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.

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 fly ash are 6, 9, 12, and 15 percent. The suggested percentages for cement kiln dust are 5, 7, and 9. The suggested percentages for portland cement are 3, 5, and 7. Other percentages may be used.

Determine the recommended percentage of stabilization additive based on the unconfined compressive strength of the specimens.

For Portland Cement: Using the cured samples, select an additive percentage that gives at least an increase of 50 psi above the unconfined compressive strength of the untreated soil and has at least a minimum unconfined compressive strength of 200psi and a maximum of 350psi. 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.

For fly ash and cement kiln dust: 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.

If there is 5 percent or more rock (plus No. 4) in the sample, adjust the stabilization additive percentage for the rock by the following factor:

Stabilization Additive, % (adjusted) = % Stabilization Additive x % Passing No. 4 / 100

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.

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.

If there is 5 percent or more rock (plus No. 4) in the sample, adjust the stabilization additive percentage for the rock by the following factor:

Stabilization Additive, % (adjusted) = % Stabilization Additive x % Passing No. 4 / 100

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.

D) 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 A) to determine the recommended stabilization additive percent.

E) 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.