

## **OHD L-51 SOIL MODIFICATION MIX DESIGN PROCEDURE**

Soil modification makes clayey soils more workable, and allows construction of a stable, working platform for paving. The benefits of modification are not significant enough or durable enough to consider in the structural design of the pavement. If a structural layer is desired, soil stabilization should be used. Soil modification is restricted to clayey soils of the AASHTO M145 Soil Groups A-4, A-5, A-6, and A-7.

The soil modification mix design procedure consists of two methods. The first method consists of an abbreviated laboratory test procedure with determination of the recommended percentage of modification additive from the Soil Modification Table. The second method is the complete laboratory test procedure with determination of the recommended percentage of modification additive from the test results. The second method is used if requested due to specific concerns on a project. The laboratory test procedure follows the general requirements of ASTM D 6276 and the PI reduction method. The modification additive and water used in the mix design procedure shall be from the source proposed for use on the project. Laboratories performing soil modification mix designs shall be qualified by the Materials Division.

### **A) Initial Soils Testing:**

Process the soil sample according to T87. 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. If the sample is not classified as one of the groups listed in the soil modification table, modification is not appropriate and other alternatives should be considered.

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 be taken throughout the length represented by the sample. If the soluble sulfate content is greater than 1000ppm for any of the additional samples, modification with calcium-based additives may not be suitable. If the soluble sulfate content is greater than 8000ppm for any of the additional samples, modification with calcium-based additives is not recommended.

For samples from Divisions 2, 5, or 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, 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, and 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) Fly Ash, Cement Kiln Dust, or Portland Cement Modification:

Verify the modification additive is from an approved source. Determine the recommended percentage of modification additive from the table. If requested due to concerns over a specific soil, use the PI reduction method as follows.

- Mix the modification additive into the soil sample (minus 40 material) at a moisture content equal to the plastic limit.
- Cover the soil-modification additive mixtures with plastic film or bag and loose cure in a moisture room for 48 hours.
- Dry and prepare the cured soil-modification additive mixtures for testing in accordance with AASHTO T-87.
- Determine the liquid limit, plastic limit, and plasticity index in accordance with AASHTO T-89 and T-90.
- Prepare a plot of plasticity index versus modification additive percentage. The percent modification additive that reduces the plasticity index by 2% per 1% increase in additive is considered to be optimum. Any additive content at or below the optimum that gives the desired modification may be recommended. The plasticity index shall be reduced to a maximum value of 10.

Three or more percentages of modification additive shall be tested in addition to the untreated soil. Suggested percentages for portland cement and cement kiln dust from pre-calciner plants are 2, 3, and 4. Suggested percentages for cement kiln dust from other type plants are 4, 6, and 8. Suggested percentages for fly ash are 5, 7, and 9 percent. Other percentages may be used.

C) Lime Modification:

Verify the modification additive is from an approved source. Determine the recommended percentage of modification additive from the table. If requested due to concerns over a specific soil, follow the requirements of ASTM D 6276 to determine the estimated lime percentage required for stabilization. Multiply the estimated lime percentage required for stabilization by 0.60 and round to the nearest 0.5% to determine the recommended lime percentage required for modification.

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 modification 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) Mix Design Report:

The mix design report shall include the following information, when applicable:

- AASHTO group classification of raw soil.
- Soluble sulfate content of soil.
- Recommended percent modification additive and source.
- Density and optimum moisture content for raw soil.
- Density and optimum moisture content for soil containing the recommended percentage of modification additive.

F) Soil Modification Table

When using the abbreviated laboratory test procedure, the recommended percentage of modification additive shall be determined by the AASHTO soil group as detailed in the following table.

<b>SOIL MODIFICATION TABLE</b>					
<b>ADDITIVE</b> (Expressed as a percentage added on oven dry basis)	<b>SOIL GROUP CLASSIFICATION - AASHTO M145</b>				
	A-4	A-5	A-6	A-7	
				A-7-5	A-7-6
<b>PORTLAND CEMENT</b>	3	3	3		
<b>FLY ASH</b>	9	9	9		
<b>CEMENT KILN DUST (Pre-Claciner Plant)</b>	4	4	4		
<b>CEMENT KILN DUST (Other Type Plant)</b>	8	8			
<b>HYDRATED LIME*</b>			3	3**	3**

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-Claciner plants are identified on the Materials Division approved list for cement kiln dust.

\* = Reduce quantity by 20% when quick lime is used, i.e. 3% x 0.8 = 2.4%, 4% x 0.8 = 3.2%

\*\* = Use 4% when the liquid limit is greater than 50.

07/28/09	Revised description at beginning of procedure.
	Soil Modification Table moved from beginning to new Section F. Revised recommended percentages for cement kiln dust and fly ash.