FULL-DEPTH RECLAMATION WITH CEMENT STABILIZATION: OVERVIEW OF DESIGN PROCESS

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1. For projects for which full-depth reclamation (FDR) is desired, a representative sample of the in-situ materials must be obtained for laboratory testing in order to determine the optimum cement content. The most valuable samples are those that are blended in the field at the same ratio of reclaimed asphalt pavement (RAP) to base that will be expected during construction and crushed using the same kind of equipment that will be used for blending in the field so that the sample gradation will be representative of the field gradation achieved in the FDR process. A minimum sample size of 100 lb is recommended.

2. The water-soluble sulfate concentration of the sample should be determined first according to American Society for Testing and Materials (ASTM) C1580. If the sulfate concentration exceeds 3000 ppm, stabilization using cement or any other calcium-based binder may not be appropriate due to the possibility of deleterious chemical reactions between the cement and the sulfate.

3. The blended material should then be subjected to particle-size analysis and Atterberg limits testing following ASTM C136 and D4318, respectively, so that the American Association of State Highway and Transportation Officials (AASHTO) soil group can be identified in accordance with AASHTO M145. The Portland Cement Association (PCA) *Soil-Cement Laboratory Handbook* may then be referenced to determine appropriate trial cement contents from the AASHTO soil classification. For many roads in northern Utah, cement contents between 2 and 6 percent are typical. Selection of three trial cement contents is common.

4. In accordance with ASTM D558, a moisture-density curve should then be prepared for the material treated at each cement concentration level and using the appropriate compaction effort. For granular base materials with adequate subsurface support in the field, modified Proctor compaction is appropriate. Standard Proctor compaction may be recommended if the reclaimed layer will be compacted over soft subgrades. PCA protocols given in the *Soil-Cement Laboratory Handbook* for weighing out and blending the RAP-base blend and cement should be followed. Preparation of cylindrical specimens with diameters and heights of 4.0 in. and 4.6 in., respectively, is most common.

5. At least three cylindrical samples with diameters and heights of 4.0 in. and 4.6 in., respectively, should then be prepared at each of the selected trial cement contents and the appropriate optimum moisture contents using the same compaction effort applied in preparation of the moisture-density curves. These samples should be cured for 7 days at room temperature and 100 percent relative humidity.

6. For roadways to be constructed in northern Utah, vacuum saturation of the cured cylinders is recommended immediately before unconfined compressive strength (UCS) testing to simulate freeze-thaw damage. Vacuum saturation and 7-day UCS testing should be performed in accordance with ASTM C593 and D1633, respectively. A cement content corresponding to 7-day UCS values between 400 and 500 psi following vacuum saturation should be recommended for use on the project. Lower cement concentrations may not provide adequate long-term durability, and higher cement concentrations may lead to undesirable shrinkage cracking of the base layer. If evaluating the effects of frost damage is not warranted for the project, then the cured cylinders should instead be soaked underwater for 4 hours immediately prior to the UCS testing.

7. A layer coefficient for the cement-treated base material may be determined from the 7-day UCS test results using correlation charts available in the AASHTO *Guide for Design of Pavement Structures*. For 7-day UCS values in the range of 400 to 500 psi, the layer coefficient will be between 0.16 and 0.18, although many agencies specify a value of 0.20 for cement-treated base with this level of strength. The layer thickness may then be determined using standard AASHTO design procedures. For single-lift construction using conventional equipment, the layer thickness should not exceed 8 to 10 in.; adequate compaction of thicker layers may not be possible. Microcracking of the cement-treated layer should be specified to minimize the possibility of reflection cracking into the pavement surface if asphalt is specified as the wearing course.

8. Application of cement in urban environments can be easily accomplished using the patent-pending slurry spreader developed by Brigham Young University and Salt Lake City Corporation personnel with support from the Portland Cement Association. Depicted in Figure 1, the application is dust-free and has been shown in research to achieve levels of uniformity similar to those achieved using the conventional application of dry cement powder.

Figure 1. Application of cement slurry on an urban pavement reconstruction project.