INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS

MIX DESIGN PROCEDURE FOR FULL DEPTH RECLAMATION (FDR) WITH CEMENT
ITM No. 595-19

1.0 SCOPE

1.1 This method covers the procedure for mix design of Full Depth Reclamation of pavements with cement.

1.2 This ITM may involve hazardous materials, operations, and equipment and may not address all of the safety problems associated with the use of the test method. The user of the ITM is responsible for establishing appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2.0 SIGNIFICANCE AND USE

2.1 This ITM is used to determine the appropriate mix design for an individual asphalt roadway by ensuring the sampled material with corresponding mix design meets specification requirements.

2.2 This ITM is used to perform mix design procedure for Full Depth Reclamation with cement.

3.0 REFERENCES.

3.1 AASHTO Standards

T 11 Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
T 27 Sieve Analysis of Fine and Coarse Aggregates
T 49 Standard Test Method for Penetration of Bituminous Materials T 88 Particle Size Analysis
T 89 Liquid/Plastic Limit

T 180 Moisture-Density Relations of Soils, Method D T 208 Unconfined Compression
T 265 Moisture Content

3.2 ASTM Standards

ASTM D1632 Creating and Curing Soil-Cement Specimens
ASTM D1633 Compressive Strength of Molded Soil-Cement Cylinders

4.0 TERMINOLOGY. Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101.

4.1 FDR- Full Depth Reclamation

4.2 RAP- Reclaimed Asphalt Pavement

4.3 Constant mass- shall be defined as the mass at which further drying does not alter the mass by more than 0.5 percent in 2 hours.

4.4 Base Material- aggregate type material directly below a bituminous pavement.

4.5 Subgrade- The upper portion of a roadbed upon which the pavement structure and shoulders are constructed.

4.6 Mix Design Blend- The selected percentages, by weight, of RAP, Base Material, Subgrade, and/or other additional materials to be used throughout the mix design that accurately represents the chosen depth of treatment, material proportions, and material type that will be encountered during FDR construction.

5.0 APPARATUS.

5.1 Cure Room, capable of maintaining room temperature of 72±3°F and a relative humidity of 100%.

5.2 Compaction hammers and molds in accordance with AASHTO T 180.

5.3 Compression Testing Machine meeting the requirements of Section 5.1 of ASTM D1633

5.4 Scale, capable of showing a reading to the nearest 0.1 gram.

5.5 Miscellaneous lab equipment; scoops, pans, mixing bowls, containers

6.0 SAMPLING.

6.1 A mix design shall be performed with the materials to be encountered during FDR construction, including in-place pavements, aggregate base, corrective aggregate, subgrade, and cement. If construction materials change significantly between the time of sampling and construction, additional mix designs shall be performed to establish a representative mix for the project.

6.2 Samples of the existing pavement are collected as cores, test pits or milled RAP. Samples that represent the entire depth of treatment shall be collected, including any underlying materials and layers, which shall be kept separately.

6.3 The composition of in-place pavement should be examined. Location and placement of pavement samples shall accurately reflect variations in the pavement and form a representative sample of the entire project. Each mix design requires a minimum sample size of 350 lbs.

6.4 Samples from significantly different pavement sections shall be grouped separately, with separate mix designs performed for each section. Examples of these variations include large patches, significantly different asphalt mixes and significantly different pavement thicknesses.

6.5 One sample per lane mile shall be the minimum sampling frequency for mix design preparation.

7.0 PREPARATION OF TEST SPECIMENS.

7.1 Sample Preparation Procedure

7.1.1 Pavement samples shall be cut, if necessary, to a depth that accurately represents the FDR treatment to take place, also accounting for pre-milling that may take place in the field.

7.1.2 Sampled pavement shall be crushed using a laboratory crusher or other methods to pass the 1.5-inch sieve, although care should be taken to avoid fracturing the aggregate.

7.1.3 Ensure materials, including RAP, aggregate base and/or other additional materials are stored and prepared separately. Prior to batching specimens, ensure these materials are dried to constant mass in a forced draft oven and thoroughly mixed.

7.2 Material Proportioning for Mix Design Blend

7.2.1 The material proportions should be determined by dry weight in direct proportion to the thickness of RAP, aggregate base, subgrade encountered during sampling. These materials should then be subjected to sieve analysis, in accordance with AASHTO T 27, to verify that proper gradation has been achieved. If proper gradation in accordance with Table 7.2.1 is not achieved, corrective aggregate will need to be added to the mix design.

Table 7.2.1: FDR Mix Design Blend Gradation Criteria

Sieve Size		Percent Passing
2 in.	50 mm	100%
1 in	25 mm	95-100%
No. 4	4.75 mm	≥55%
No. 200	75 µm	2-20%

7.2.2 Once the gradation is in accordance with Table 7.2.1, the mix design blend shall be subjected to a moisture-density relationship test in accordance with AASHTO T 180. The resulting maximum dry density (MDD) value shall be used to determine the weight of cement to be added for each specimen set. The optimum moisture content (OMC) shall be used to determine a minimum moisture content of the mixture prior to introduction of cement.

7.3 Cement Content Selection

7.3.1 Mix designs shall be performed using Type 1 Portland cement from an INDOT approved source.

7.3.2 Select at least three cement contents in increments of 0.5 to 1.0 percent within a suggested starting range of 4.0 to 6.0 percent by dry weight of the mix design blend.

7.4 Mixing Procedure

7.4.1 Mixing occurs at room temperature, per 5.1. One specimen shall be mixed at a time. Design Moisture Content, determined through the moisture density relationship in 7.2.2, plus 2%, shall be the amount of water added to the mix design blend prior to mixing. The moisture shall be added to the mix design blend 16 hours prior to the addition of cement.

7.4.2 Using a mechanical bucket mixer, begin mixing batched material at 50-75 revolutions/minute. The mixture may also be incorporated by hand.

7.4.3 Mix for no less than 60 seconds in the mechanical mixer or 120 seconds by hand.

7.4.4 Add pre-weighed amount of cement.

7.4.5 Mixing time to incorporate cement shall be approximately one minute.

7.5 Determination of Mix Design Blend and Cement MDD and OMC. The mixture with cement shall be immediately subjected to a moisture-density relationship test in accordance with AASHTO T 180. This process shall include the generation of 3 additional points at higher moisture contents to generate a proctor curve. The resulting maximum dry density value shall be used as a reference from which to determine the density of strength specimens. The resulting optimum moisture content shall be used to determine the moisture content of the mixture prior to compaction.

7.6 Generation of Test Specimens

7.6.1 Using the maximum dry density and optimum moisture content determined in 7.5, strength specimens will need to be created at 95% to 100% of the MDD at OMC.

7.6.2 The mixture with cement shall be mixed in accordance with 7.4 except that the moisture content used shall be the OMC determined in Section 7.5.

7.6.3 After Mixing Procedure detailed in 7.4, remove the mixture and create unconfined compression strength specimens in accordance with ASTM D1632.

7.6.4 Store specimens in cure room in accordance with ASTM D1632 for 7 days.

7.6.5 After curing, remove from cure room and bag. Remove any excess water with damp cloth.

8.0 UNCONFINED COMPRESSION STRENGTH TESTING

8.1 Test each specimen to failure in accordance with ASTM D1633.

9.0 CALCULATIONS.

9.1 Unconfined Compression Strength. Calculate unconfined compression strength of each pill according to ASTM D1633. The average strength of two pills from a particular cement content shall constitute the result.

9.2 Selecting a Final Design Cement Content

9.2.1 Graph the strength vs. cement content data and draw a trend line.

9.2.2 Select and report the minimum cement content that meets or exceeds mix design requirements detailed in the project specifications.

10.0 REPORT.

10.1 Executive Summary

10.2 Coring and Sampling Report. Shall include photos.

10.3 Field Mix Design. All mix design test results and additional additives shall be reported to the Department. At a minimum, the report shall contain design moisture content, final design cement content, gradation, corrective aggregate, etc.