VT-AOT MRD 38-86 – Vermont Test for Conducting an Annual Testing Program of Structural Concrete Aggregates

VT-AOT MRD 39-86 – Vermont Test for % Pigment, % Vehicle in Mixed Paints, and % Volatiles and Non Volatiles in Vehicle

VT-AOT MRD 40-86 – Vermont Test for Determination of PCC Pavement Thickness for Final Acceptance and Payment

VT-AOT MRD 41-88 – Vermont Test for Determining Corrosion Activity in Reinforced Concrete

VT-AOT MRD 42-88 – Vermont Test for Determining Corrosion Activity of Membrane Waterproofed Bridge Decks

VT-AOT MRD 43-89 – Vermont Test for Approval of Flexible Delineators

VT-AOT MRD 44 – Obsolete

VT-AOT MRD 45 – Replaced by ASHTO T-209

VT-AOT MRD 46-94 – Vermont Test for Inspecting Durable Pavement Markings

VT-AOT MRD 47-95 – Vermont Test for Determination of Total Chloride Ion Content of Cementitious Material

VT-AOT MRD 48-97 – Vermont Test for Calcium Oxide

VT-AOT MRD 49-97 – Vermont Test for Insoluble Residue

VT-AOT MRD 50-97 – Vermont Test for Loss on Ignition

VT-AOT MRD 51-97 – Vermont Test for Magnesium Oxide

VT-AOT MRD 52-97 – Vermont Test for Silicon Dioxide in Portland Cement

VT-AOT MRD 53-97 – Vermont Test for Sulfur Trioxide

VT-AOT MRD 54-09 – Vermont Test for Target Density Determination for Subbase Compaction Control

VT-AOT MRD 55-06 – Vermont Test for Determination of Subbase Compaction

VT-AOT MRD 56-09 – Vermont Test for Determination of the presence of the Anti-Caking Agent YPS

VT-AOT MRD 57-09 – Vermont Test for Determination of Acid-Insoluble Residue in Aggregate

VT-AOT MRD 58-12 – Vermont Test for Determination of Unixial Compressive Strength of Rock Cores

Prepared By: WLM W. L. Meyer
Date: 01/17/86
Page: 1 of 2

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

VT-AOT-MRD 38-86

VERMONT PROCEDURE FOR CONDUCTING AN ANNUAL TESTING PROGRAM OF STRUCTURAL CONCRETE AGGREGATES

Samples of aggregates for concrete are obtained annually from all available sources. Tests are performed to determine specification compliance and to provide information for designing concrete mixtures. Sampling and testing is shared by the Structural Concrete Subdivision and Compliance Testing Subdivision.

A. Sampling

Samples are usually obtained during the Fall months (October-December) to permit testing as part of the winter program. Following specified sampling procedures, three bags of 3/4 inch coarse aggregate and two bags each of 3/8 inch coarse aggregate and fine aggregate are obtained. The sampling containers shall be clean, closely woven cloth bags provided by the Central Laboratory. Samples are identified for size and source and transported to the Central Laboratory.

A "Laboratory Number" is assigned to each sample by the Structural Concrete Subdivision. This number is used to identify the sample in all stages of testing and reporting.

B. Storage of Samples

Prior to testing, the samples are stored in an assigned area of the open stalls, northwest of the State Garage. Samples are stored on wooden pallets to permit air-drying of the aggregates and prevent rotting of the cloth bags. Samples are laid flat, one source (seven bags) per pallet.

C. Tests Performed by Structural Concrete Subdivision

The Structural Concrete Subdivision is responsible for performing the following tests:

1) Unit weight of Aggregate AASHTO T19 (Dry Rodded)
2) Specific Gravity and Absorption of Fine Aggregate AASHTO T84
3) Specific Gravity and Absorption of Coarse Aggregate AASHTO T85

D. Tests Performed by Compliance Testing Subdivision

The Compliance Testing Subdivision is responsible for performing the following tests:

1) Soundness of Aggregate by use of Sodium Sulfate or Magnesium Sulfate AASHTO T104 (Sodium Sulfate).

2) Resistance to abrasion of small size Coarse Aggregate by use of the Los Angeles Machine AASHTO T96.

3) Determination of Thin and/or Elongated particles in Coarse Aggregate Vt. AOT MD22.

4) Determination of Coarse Aggregate Particles with Fractured Faces VT AOT MD23.

5) Compressive Strength of Mortar - in accordance with Section 704.01(c) Vermont Agency of Transportation Standard Specifications for Highway and Bridge Construction.

E. Preparation of Report

The Structural Concrete Subdivision shall prepare, for each sample, an "Annual Aggregate Testing Program Summary" Form Number TA 570G. Data is further processed by preparing an "Annual Aggregate Testing Program - (Year) Composite Summary" Form Number TA 570G1 showing all testing program results for the designated year.

R.J.N.
01-29-86

Prepared By: R. J. O'Brien
June 5, 1986

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

VERMONT TEST FOR % PIGMENT, % VEHICLE IN MIXED PAINTS, AND % VOLATILES & NON VOLATILES IN VEHICLE
VT-A.O.T.-MRD 39-86

1. Scope

A test based on Federal Test Method Standard 141B for the determination of % pigment and % vehicle in mixed paints.

2. Apparatus

2.1 Analytical balance capable of weighing to 0.01 mg.

2.2 Microcentrifuge capable of developing 13,000 x G such as Fisher Model 235B or equivalent.

2.3 Microcentrifuge tubes 1.5 mL such as Fisher 05-407-5 or equivalent.

2.4 Convection Oven capable of maintaining a temperature of 110°C± 1°C.

2.5 Aluminum weighing dishes 57 mm such as Fisher 8-732 or equivalent.

2.6 Vibrator such as Scientific Industries "Vortex-Genie", Model K 550-G, Scientific Industries, Inc., Bohemia, New York or equivalent.

3. Chemicals

1:1 acetone-toluene extraction mixture.

4. Procedure

4.1 _% Pigment and % Vehicle_ - Weigh the centrifuge tube to the nearest 0.01 mg. Transfer between 0.5 and 1.0 g paint sample to the tube, cap and weigh again. Add 1:1 acetone-toluene extraction solvent to tube, leaving a small headspace of about 3 mm. Vibrate for approximately 15 seconds to dispense pigment and extract vehicle. Centrifuge for 1.5 minutes. Pour off supernatant liquid and retain for further analysis if desired. Repeat extraction two times, centrifuging for 2 minutes on the last extraction. Place centrifuge tube containing pigment in convection oven for 1.5 hours at 110°C± 1°C. Cool to room temperature and immediately weigh.

Calculation:

$$TP - T = P$$

$$[TPg - T = Pg]$$

$$\frac{Pg}{P} \times 100 = \%\ Pg$$

$$[100 - \%\ Pg = \%\ V]$$

Where:

TP = Wt. tube & paint (grams)
T = Wt. tube (grams)
P = Wt. paint (grams)
TPg = Wt. tube & dried pigment (grams)
Pg = Wt. pigment dried (grams)
% Pg = % pigment
% V = % vehicle

NOTE: For convenience of calculation and record retention use worksheet Form TA 422-A2C, 8/81.

4.2 <u>% Volatiles and Non-Volatiles in Vehicle</u> - Weigh the aluminum dish to the nearest 0.01 mg. Rapidly transfer between 0.2 and 0.6 g paint sample to the dish and <u>immediately</u> weigh again.[1] Add 2-3 mL of 1:1 acetone-toluene mixture to dish and agitate to disperse paint evenly over bottom of dish. Place dish in convection oven for 1.5

hours at 110°C± 1°C. Cool to room temperature and immediately weigh again.

Calculation:

$$DP - D = P$$

$$DS - D = S$$

$$\frac{S}{P} \times 100 = \% S$$

$$100 - \% S = \% Vol$$

$$\left[\frac{\% Vol}{\% V} = \% Vol/V\right]$$

$$[100 - \% Vol/V = \% N Vol/V]$$

Where:

D = Wt. dish (grams)

DP = Wt. paint & dish (grams)

P = Wt. paint (grams)

DS = Wt. dish & solids after oven (grams)

% S = % solids

% Vol = % volatiles in paint

% V = % vehicle as determined by 4.1

% Vol/V = % volatile in vehicle

% N Vol/V = % non volatile in vehicle

NOTE: For convenience of calculation and record retention use worksheet Form TA 422-A2C, 8/81.

[1] As the evaporation of volatiles from the paint is rapid, the transfer and weighing must be accomplished as quickly as possible. It is recommended that a disposable borosilicate Pasteur pipet of 5 3/4 inch length (Fisher 13-678-20B) be used for the transfer.

CCB

Prepared By: C. C. Benda
September 16, 1986

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
VT A.O.T. - MRD 40-86

VERMONT STANDARD PROCEDURE FOR DETERMINATION OF PCC PAVEMENT THICKNESS FOR FINAL ACCEPTANCE AND PAYMENT

1. Scope

1.1 This method covers the procedure for obtaining and testing drilled cores for thickness determinations for final acceptance and payment of Portland cement concrete pavement, Item 408.30.

2. Apparatus

2.1 **Core drill,** for obtaining 4 inch diameter core specimens. The drill shall be capable of coring the full depth of the pavement.

2.2 **Calipering device** that will measure the length of axial elements of the core. While the details of the mechanical design are not prescribed, the apparatus shall conform to the requirements of paragraphs 2.2.1 to 2.2.5.

2.2.1 The calipering apparatus shall be so designed that the specimen will be held with its axis in a vertical position by three symmetrically placed supports bearing against the lower end. These supports shall be short posts or studs of hardened-steel, and the ends that bear against the surface of the specimen shall be rounded to a radius of not less than 1/4 inch and not more than 1/2 inch.

2.2.2 The apparatus shall provide for the accommodation of specimens of different nominal lengths over a range of at least 4 to 10 inches.

2.2.3 The calipering device shall be so designed that it will be possible to make a length measurement at the center of the upper end of the specimen, and at eight additional points spaced at equal intervals along the circumference of a circle whose center point coincides with that of the end area of the specimen and whose radius is not less than one half nor more than three fourths of the radius of the specimen.

2.2.4 The measuring rod or other device that makes contact with the end surface of the specimen for measurement shall be rounded to a radius of 1/8 inch. The scale on which the length readings are made shall be marked with clear, definite, accurately spaced graduations. The spacing of the graduations shall be 0.10 inch or a decimal part thereof.

2.2.5 The apparatus shall be stable and sufficiently rigid to maintain its shape and alignment without a distortion or deflection of more than 0.01 inch during all normal measuring operations.

3. Sampling Procedure

3.1 A minimum of one core shall be taken in each lane for every 1,000 linear feet of pavement. Cores used as specimens for length measurement shall be drilled with the axis normal to the surface of the pavement. Cores that show abnormal defects or that have been damaged appreciably in the drilling operation shall not be used.

3.2 Any core deficient in thickness by 1/4 of an inch or greater shall have a check core taken each side of the deficient core at a distance of approximately 10 feet away. If either of the check cores proves unsatisfactory, additional cores will be taken at 10 foot intervals parallel to centerline until a core which is no longer deficient is extracted. In no case shall a core be taken closer than 18 inches from a pavement joint. Each core will be tested for thickness and rated individually as outlined in 4.1 to 4.3

4. Testing Procedure

4.1 Before any measurements of the core length are made, the apparatus shall be calibrated with suitable gauges so that errors caused by mechanical imperfections in the apparatus are known. When these errors exceed 0.01 inches, suitable corrections shall be applied to the core length measurements.

4.2 The specimen shall be placed in the measuring apparatus with the smooth end of the core, that is, the end that represents the upper surface of a pavement, placed down so as to bear against the three hardened-steel supports. The specimen shall be so placed on the supports that the central measuring position of the measuring apparatus is directly over the mid-point of the upper end of the specimens.

4.3 Nine measurements of the length shall be made on each specimen, one at the central position and one each at eight additional positions spaced at equal intervals along the circumference of the circle of measurement described in Apparatus, paragraph 2.2.3. Each of these nine measurements shall be read directly to tenths of an inch and either directly or by estimation to five-hundredths of an inch.

Note - If, in the course of the measuring operation, it is discovered that at one or more of the measuring points the surface of the specimen is not representative of the general plane of the core end because of a small projection or depression, the specimen shall be rotated slightly about its axis and a complete set of nine measurements made with the specimen in the new position.

5. Report

5.1 The average of the nine measurements expressed to the nearest 0.10 inch shall be reported as the length of the concrete core.

Prepared By: P. C. Winters
Date: March 28, 1988
Page: 1 of 2

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
VT - A.O.T. - MRD 41-88

Method of Test for Determining Corrosion Activity in Reinforced Concrete

1. Scope

1.1 This method covers the procedure for taking half-cell potential measurements of reinforcing steel in reinforced concrete structures.

2. Significance & Use

2.1 This practice may be used in conjunction with other test methods in determining the general condition of concrete bridges or other reinforced concrete structures.

2.2 It's particular use is for aquiring electrical potential readings as an indicator of the existance, or lack thereof, of active corrosion in reinforcing steel.

3 Apparatus

3.1 M. C. Miller reference electrode and meter; meter base; extension rod; reel containing 100' of lead wire; short wire with an alligator clip on one end and a male plug on the other; 1/2"± X 3"± X 5"± sponge; generator; electric rotary drill capable of drilling a 1-1/4" diameter hole through bituminous or Portland cement concrete courses; air compressor with air hose and nozzle; pump-up type garden sprayer; Pacometer; 3/8" electric drill and bits; 6" sections of 3/32" brass welding rod; hammer; water cans; fuel for generator; a quick setting concrete patching product; measuring tape, lumber crayons, and paint for marking decks; and a vehicle capable of carrying the supplies, personnel and equipment.

4. Reading Location Selection

4.1 Layout bridge deck using the measuring tape(s), and construct a grid or other location system on the deck surface using lumber crayon or paint to mark the points where readings are required. Density of grid or other pattern may vary with the situation, but generally consists of a 5' grid plus readings along each curb line.

4.2 On other structures such as pier caps, columns, etc., the pattern or grid used shall be consistent with the member being investigated and the intended use of the measurements.

5. Test Procedure

5.1 At one location in each interconnected mass of concrete, using the Pacometer, locate reinforcing steel and drill a 1-1/4" hole to the steel. Using the 3/8" drill and 3/32" bit, drill into the steel a hole 3/32" X 1/2"± depth and insert the 3/32" pin to act as a ground connection. Using the hammer gently tap the end of the pin to firmly seat it in the steel.

5.2 Assemble the meter atop the meter base and extension rod. Assemble the copper sulfate 1/2 cell electrode to the bottom of the extension and attach a wet sponge 3" X 5" X 1/2"(±1/8") to the bottom of the electrode with a rubber band.

5.3 Connect the alligator clip on the short wire to the pin in the steel and the other end to the jack in the wire spool (on some spools it will be necessary to reel out the long wire before connecting the reel to the steel pin).

5.4 Connect the wire on the meter base to the upper left hand jack in the meter, then connect the plug end of the 100' reel to the center jack in the meter.

5.5 Using the hand sprayer, wet the surface at each location where a reading is to be taken. Wetting is to be done with water which, if needed, can contain a wetting agent and/or anti-freeze agent.

5.6 With the meter assembled, as in Steps 5.2 - 5.4, take readings at each location.

6. Filling Holes

6.1 After readings have been taken fill all holes which were drilled with a quick setting concrete patching product used according to its manufacturer's instructions.

7. Reporting

7.1 Plot the readings on a scaled map of the deck surface. Compile plots with other information as required, such as bridge location, date of testing, etc.

PCW

Prepared By: P. C. Winters
Date: March 16, 1988
Page: 1 of 2

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
VT - A.O.T. - MRD 42-88

Method of Test for Determining Corrosion Activity on Membrane Waterproofed Bridge Decks

1. Scope

1.1 This method covers the procedure for taking half-cell potential measurements of reinforcing steel on bridge decks treated with a waterproofing membrane.

2. Significance & Use

2.1 This practice may be used in conjunction with other test methods in determining the general condition of concrete bridge decks.

2.2 It's particular use is for aquiring electrical potential readings as an indicator of the existance, or lack thereof, of active corrosion in reinforcing steel where a waterproofing membrane would otherwise prohibit the aquisition of the readings.

3. Apparatus

3.1 M. C. Miller reference electrode and meters; meter base; extension rods; reel containing 100' of lead wire; short wire with an alligator clip on one end and a male plug on the other; 1/2" X 1/2"±1/8" X 3" sponge; 1/2"±1/8" X 3"± X 5"± sponge; 1/2" plastic pipe nipple; generator; electric rotary drill capable of drilling 3/4" diameter hole through bituminous courses; air compressor with air hose and nozzle; pump-up type hand garden sprayer; Pacometer; 3/8" electric drill and bits; 6" sections of 3/32" brass welding rod; hammer; water cans; fuel for generator; 30 oz. size caulking guns; necessary tubes of one-part self-leveling polyurethane sealant; measuring tape, lumber crayons, and paint for marking decks; and a vehicle capable of carrying the supplies, personnel and equipment.

4. Bridge Deck Layout

4.1 Using the measuring tape(s), construct a grid or other location system on the deck surface using lumber crayon or paint to mark the points where readings are required. Density of grid or other pattern will vary with the situation.

5. Test Procedure

5.1 At one location per span, using the Pacometer, locate reinforcing steel and drill a 1-1/4" hole to the steel. Using the 3/8" drill and 3/32" bit, drill into the steel a hole 3/32" X 1/2"± depth and insert the 3/32" pin to act as a ground connection. Using the hammer gently tap the end of the pin to firmly seat it in the steel.

5. Test Procedure - Continued

5.2 At each test location marked on the deck, using the generator for power and the electric drill, bore a 3/4" hole to the concrete deck through the pavement and membrane. Then blow out the the pulverized concrete dust with compressor.

5.3 Insert the small (1/2" X 1/2"±1/8" X 3") sponge into the pipe nipple and saturate the sponge. Insert the nipple/sponge unit into the 3/4" hole seating it against the concrete deck at the bottom. Note: The sponge should protrude slightly from either end of the plastic pipe nipple. Where the bituminous overlay exceeds 3", a longer sponge and nipple will be required.

5.4 Assemble the meter atop the meter base and extension rod. Assemble the copper sulfate 1/2 cell electrode to the bottom of the extension and attach a wet sponge 3" X 5" X 1/2"(±1/8") to the bottom of the electrode with a rubber band.

5.5 Connect the alligator clip on the short wire to the pin in the steel and the other end to the jack in the wire spool (on some spools it will be necessary to reel out the long wire before connecting the reel to the steel pin).

5.6 Connect the wire on the meter base to the upper left hand jack in the meter, then connect the plug end of the wire on the 100' spool to the center jack in the meter.

5.7 With the meter assembled, as in Steps 5.4 - 5.6, take readings at each location, atop the nipple/sponge assembly in each hole.

6. Sealing Holes

6.1 After readings have been taken blow all water from the holes and dry the holes. Use Ottowa Sand as a drying agent. Brief reaming with the drill bit will produce a heating action to dry the hole.

6.2 When the hole has been thoroughly dried fill it with an approved self leveling one part polyurethane sealant using the caulking gun. If air is trapped in the hole it will work up through the sealer as it levels itself. The sealer is slow drying and when the hole is full some sand or dust should be placed on top so that it will not be affected by traffic.

7. Reporting

7.1 Plot the readings on a scaled map of the deck surface. Compile plots with other information as required, such as bridge location, date of testing, etc.

VT AOT
Materials &
Research Division

TEST PROCEDURE
FOR
APPROVAL OF
FLEXIBLE DELINEATORS

Prep. By PCW PCW
Date: 6-27-89

VT-AOT-MRD 43-89

SITE: Site must provide capability of safely attaining 40 MPH and deceleration after impact.

PHASE I (SHORT TERM)

PROCEDURE:

1) Erect delineator according to manufacturer's installation instructions.

2) At 10,20,30,40, MPH, drive test vehicle through delineator.

A. Delineator must flex sufficiently to pass under the vehicle with no damage* to the vehicle.

B. After passage of the vehicle, the delineator must rebound to a vertical** position.

*Slight scratching of paint is acceptable.
**Near vertical sufficient so that the reflectorized surface will perform as intended.

PHASE II (LONG TERM)

1) Erect line of delineators (minimum 10) in actual position on ramp or other discrete roadway section and observe through at least one plowing season for damage due to snow load.

2) Observe at night for continued reflectivity after normal weather exposure i.e. freeze-thaw, sunlight (UV), rain, wind, snow, etc.

EVALUATION

1) If delineator breaks off or distorts due to bending so that the reflectorized portion is not substantialy vertical after impact test, the delineator is not acceptable. A second test will be conducted on another delineator from the same batch.

2) If, after one plowing season, the delineator is not vertical and cannot be straightened after the removal of snow/ice bank, the delineator is not acceptable.

3) If, after 1 year including one plowing season, the reflective portion is not clearly visible at 150' on a clear night then that delineator is unacceptable. If 10% or more of the delineators are unacceptable then the product is unacceptable. Damage due to accident i.e. scraped off tape or broken lens, will be excepted if repair can be made on site with hand tools in less than 5 minutes per delineator.

VT AOT
Materials &
Research Division

TEST PROCEDURE
FOR
APPROVAL OF
FLEXIBLE DELINEATORS

Prep. By PCW PCW
Date: 6-27-89

VT-AOT-MRD 43-89

SITE: Site must provide capability of safely attaining 40 MPH and deceleration after impact.

PHASE I (SHORT TERM)

PROCEDURE:

1) Erect delineator according to manufacturer's installation instructions.

2) At 10,20,30,40, MPH, drive test vehicle through delineator.

A. Delineator must flex sufficiently to pass under the vehicle with no damage* to the vehicle.

B. After passage of the vehicle, the delineator must rebound to a vertical** position.

*Slight scratching of paint is acceptable.
**Near vertical sufficient so that the reflectorized surface will perform as intended.

PHASE II (LONG TERM)

1) Erect line of delineators (minimum 10) in actual position on ramp or other discrete roadway section and observe through at least one plowing season for damage due to snow load.

2) Observe at night for continued reflectivity after normal weather exposure i.e. freeze-thaw, sunlight (UV), rain, wind, snow, etc.

EVALUATION

1) If delineator breaks off or distorts due to bending so that the reflectorized portion is not substantialy vertical after impact test, the delineator is not acceptable. A second test will be conducted on another delineator from the same batch.

2) If, after one plowing season, the delineator is not vertical and cannot be straightened after the removal of snow/ice bank, the delineator is not acceptable.

3) If, after 1 year including one plowing season, the reflective portion is not clearly visible at 150' on a clear night then that delineator is unacceptable. If 10% or more of the delineators are unacceptable then the product is unacceptable. Damage due to accident i.e. scraped off tape or broken lens, will be excepted if repair can be made on site with hand tools in less than 5 minutes per delineator.

VT-AOT

MRD 44

Obsolete

Please Note:

AASHTO T-209

Replaces

MRD 45

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
VT A.O.T - MRD 46-94

VERMONT STANDARD METHOD FOR INSPECTING DURABLE PAVEMENT MARKINGS

1. Scope:

1.1 This method covers the procedure for evaluating durable pavement markings in order to determine their durability, retroreflectivity, and skid resistance. These markings will include, but are not limited to; thermoplastic, polymer based compounds, and epoxy.

2. Apparatus:

2.1 **Retroreflectometer**, for measuring retroreflectivity of the markings in millicandellas.

2.2 **British Pendulum Tester**, for obtaining skid resistance readings on pavement markings.

2.3 **Thermometer**, for obtaining temperatures of the material, both before and after application, as well as the pavement.

2.4 **Inspection Kit**, for use during the inspection of application of the markings. Items should include duct tape, small knife, magnifier, and a roll of roofing paper.

3. Inspection Procedure:

3.1 An initial overview of the condition of the markings on the project will be achieved by a drive through. When a project is part of the pavement life study, the marking survey should be conducted in conjunction with the pavement study. Following the drive through, the project would be divided up in sections in which conditions of the surface are consistent. Each traffic stripe in these sections will then be given an overall rating using the rating values shown in Appendix A. When present, any type of distress will be noted in the Field Inspection Notes (Appendix B).

3.2 Significant losses will be noted by narrative in the Field Inspection Notes form, e.g.,"70' missing LEL MM 5.3", which means approximately 70 feet of striping totally gone from the left edge line near mile marker 5.3. Thus, significant losses will be determined as being a total loss of line for a length greater than 50 feet, or a loss in excess of 1" in the width of the line for greater than 50 feet. These losses will be also documented in the "Significant Loss " portion of the Inspection Form (Appendix C).

3.3 Each section that has a "significant loss" on a line will have the rating weighted over that entire section. The intent in doing this is to provide an overall evaluation of all pavement markings in a given section, to include both edgeline and centerline. Details of this weighted rating system are provided in the example given in Appendix D.

3.4 Each section of the project will receive a weighted rating. For projects that also involve the Pavement Life Study, sections should be keyed to test site locations. For all other projects the section length should be approximately 1/2 mile.

3.5 Should a section be significantly different from the rest of the project, that section will not be averaged into the final rating, but will be noted, both on the front of the form, and in the field notes. An example of how this might appear is presented in Appendix E.

4. Miscellaneous Markings:

4.1 Miscellaneous markings (stopbars, letters, symbols, gore markings, etc) will be noted on the bottom of the form. Each marking that has any kind of loss will be documented with a photograph. The marking will be rated using the same scale as the long lines (i.e., 1 = Poor, 2 = Fair, etc.), but the whole legend will be rated qualitatively as a unit. There will be no weighting of the rating as there was with the line striping. For example, a "STOP" may be rated as poor if only the "T" is gone and the other three letters remain.

5. Retroreflectivity:

5.1 Retroreflectivity, using the Mirolux 12 Retroreflectometer, should be sampled through a representative number of projects. Besides measuring new thermoplastic, efforts should also be made to return to areas which have had retroreflectivity measured in the past. At least three readings will be taken for each specified location. Each of these locations should be marked once the test is complete. For safety reasons, these tests will only be taken on the white edge line.

6. Skid Testing

6.1 Skid resistance, using the British Pendulum Tester (BPT), should be sampled through a representative number of projects, much the same as retroreflectvity. These should also be tested on old as well as new projects, with these test sites being collocated with the retroreflectivity test sites. Directions on how to test using the BPT are located in its carrying case. A skid resistance test will consist of a minimum of 10 readings, half taken on the pavement, and half on the marking. At least two tests should be taken within 10-20 feet of each other.

VAOT
MRD 46-94

June 27, 1994
Appendix A

RATING SYSTEM FOR PAVEMENT MARKINGS

Condition	Description	% Remain	Rating
Excellent	No apparent wear, damage or loss	95-100	4
Good	Distress is primarily cosmetic in extent, and barely noticeable from a moving vehicle, averaging less than 6"loss of material from leading edges, and less than 1/2" loss on line width	85-95	3
Fair	Distress is visible from a moving vehicle moving at normal driving speeds, but with lines still visually effective, averaging less than 24" from leading edges, and no more than 1" loss on line width	75-85	2
Poor	Some portions of the line completely lost so that delineation is not provided in localized areas. Over 24" loss from leading edges. Over 1" loss on line width	50-75	1
Failure	Most or all portions of line are completely lost. Significant safety hazard is created by missing lines	<50	0

Rating/Percentage Correlation Chart

%	Rating	%	Rating
100	4	80	1.5
98.75	3.75	77.5	1.5
97.5	3.5	75	1.0
96.25	3.25		
95	3.0	60	0.75
92.5	2.75	40	0.5
90	2.5	20	0.25
87.5	2.25		
85	2.0	0	0
82.5	1.75		

AOT
ats & Res

Thermoplastic Pavement Marking Field Inspection Sheet

Appendix B
Inspected by
____
Date________

own(s) & Project____
oute__ MM_____ to MM_______ Length___________miles, (_____ feet)

pplicator________________ Product____________ __ Alkyd __ Hydro

IELD NOTES:

MM TO MM NOTES

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AOT
ats & Res

Thermoplastic Pavement Marking
Inspection Sheet

Appendix C
Inspected by ____________
Date________

own(s) & Project______________________________District #________________
oute__ MM_____ to MM_______ Length______________miles, (__________ feet)

pplicator________________ Product____________ __ Alkyd __ Hydro

verall Rating:___________________ ______________% Remaining

VERALL CONDITION:

Excellent= 4, Good= 3, Fair= 2, Poor= 1, Total Failure= 0

MM	to MM	Rating LEL	CL	REL	AVG	Length(FT)	Weighted Rating
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________
___	___	____	____	_____	____	__________	_________________

Total Weighted Rating _________________

Average (Total Weighted Rating/Total Length of Road)__________

==

Letters and Symbols: Product_______________________

TYPE	LOCATION	#LETTERS MISSING	RATING	COMMENTS
_________	____	______________	____	______________
_________	____	______________	____	______________
_________	____	______________	____	______________
_________	____	______________	____	______________
_________	____	______________	____	______________

(Significant Losses on reverse side of form)

EXAMPLE OF WEIGHTING RATINGS

A project consists of 3.5 miles of roadway, with a double yellow line and two edge lines of thermoplastic. The first section to test consists of a portion of the road 2640 feet (0.5 mile) in length, with a loss of 150 feet (Rated 0, in accordance with Appendix A) and an undamaged length of 2490 feet (Rated 4, App A).

This would be rated by multiplying the undamaged length (2490 feet) by 4 (the rating of undamaged lines, See Appendix A). This number would then be divided by the total length of the left edge line to produce a rating for that line. This would also be done on the center and the right edge line. For purposes of evaluation the dual centerline will be considered the same as a single edge line. The computations are as follows:

	LEL	CL	REL
Length(Loss)	150	0	0
Length(Undamaged)	2490	2640	2640
Undamaged length X 4(*)	9960	10560	10560
Divided by Total Length(2640 ft)	3.77	4	4

(*) Rating for undamaged portion of line

The three ratings that are obtained can then be averaged. In this case 3.77, 4, and 4 added together and divided by 3 produce the average of 3.92. This is entered on the form as the rating for this section. This rating is then multiplied by the length of the section in feet to produce an overall rating for the section. The overall ratings for each of the sections are then added up and divided by the length of the road(in feet) to produce a final rating for the entire project. An example follows:

	Rating			Average	Length(Ft)	Weighted Rating
	LEL	CL	REL			
Sect. 1	1	2	1	1.33	1984.3	2639.11
Sect. 2	2	2	1	1.67	3987.2	6658.63
Sect. 3	1	2	2	1.67	2846.3	4753.32
					Total	14051.06
Divided by Total Length of Project						8817.8
				Weighted Average		1.593

The rating obtained through this procedure will then be correlated to a descriptive rating and percentage (See Appendix A).For this example, the numeric rating of 1.593 would correlate to a descriptive rating of "Poor", and a percentage of 76%. These two items would then be placed on top of the Inspection Form (Appendix C), and used in the future to describe the overall condition of the durable pavement markings on the road.

VAOT
Mats & Res

Thermoplastic Pavement Marking
Inspection Sheet
EXAMPLE

Appendix E
Inspected by CG
Date 7/24/01

Town(s) & Project HIGHGATE STP 9172 District # 8
Route 1 MM 0.0 to MM 0.4 Length .4 miles, (2112 feet)

Applicator ABC INC. Product PAVEMARK X Alkyd __ Hydro

Overall Rating: Excellent (for .3 miles) 99 % Remaining *

OVERALL CONDITION:
Excellent= 4, Good= 3, Fair= 2, Poor= 1, Total Failure= 0

		Rating					
MM to	MM	LEL	CL	REL	AVG	Length(FT)	Weighted Rating
0	.1	4	4	4	4	528.0	2112
.1	.2	0.969	0	0.969	0.646	528.0	See back * Not averaged in
.2	.3	4	4	3.69	3.89	528.0	2053.92
.3	.4	4	3.62	4	3.87	528.0	2043.36

Total Weighted Rating 6209.28

Average (Total Weighted Rating/Total Length of Road) $\frac{6209.28}{1584}$ 3.92

Letters and Symbols: Product

TYPE	LOCATION	#LETTERS MISSING	RATING	COMMENTS
STOP	.1	ALLGOOD	4	

(Significant Losses on reverse side of form)

VAOT
Mats & Res

Thermoplastic Pavement Marking
Field Inspection Sheet

Appendix ~~B~~E
Inspected by
Date 7/25/94

Town(s) & Project Highgate STP9172
Route 1 MM 0.0 to MM 0.4 Length .4 miles, (2112 feet)

Applicator________ Product________ __ Alkyd __ Hydro

FIELD NOTES:

MM	TO MM	NOTES
0	0.1	LEL, EL, CL all look good
0.1	0.2	CL completly gone
		app 400' gone left and right edgeline
0.2	0.3	CL LEL looks good
		40' gone from REL
0.3	0.4	LEL REL look good
		CL lost 50'

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION
VT A.O.T. - MRD 47-95

VERMONT STANDARD METHOD FOR DETERMINATION OF TOTAL CHLORIDE ION CONTENT OF CEMENTITIOUS MATERIAL

1. Scope:

1.1 This method describes the procedure for determining the total chloride ion content of cementitious material. The test results, reported in parts per million (ppm) assist in determining the extent of road salt (sodium chloride) intrusion of portland cement concrete structures. The method is based on AASHTO Standard Method of Test T 260-93, (Appendix A) "Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Material", Procedure A, and replaces VT A.O.T. - MRD 20 (Appendix B). This document contains several deviations from the AASHTO standard, due to the use of the Mettler DL25 titrator as well as conclusions drawn from a study on the comparison of chloride determination test procedures (Work Plan No. 94-R-27). This test method should be read in its entirety prior to attempting these procedures.

2. Equipment:

2.1 All equipment, chemicals and materials required for this procedure can be found in the Chemistry Laboratory at the Materials & Research Central Laboratory and are listed below.

(1) Exhaust hood with fan
(1) Mettler DL25 titrator with printer
(1) Balance accurate to at least 0.001 gram
(1) Medium temperature hot plate (250-400^{0}C Surface Temp.)
(1) Small "U" shaped magnet
(1) Standard 0.300 mm (#50) sieve with pan
(1) Porcelain Mortar and Pestle
(1) 1" wide paint brush
(10) 100 ml Pyrex (or equiv.) glass beaker
(2) 500 ml Pyrex (or equiv.) glass beaker
(10) Glass stirring rod
(10) 80 ml glass titration vessel
(2) Glass graduated burette with 0.1 ml graduations
(1) Burette stand
(3) 1000 ml Plastic squeeze-type bottle for D.I. Water
(1) 25 ml graduated cylinder
(1) Metal laboratory spatula
Compressed air source

3. Reagents:

3.1 Digestion: Concentrated HNO_3 (nitric acid)
3.2 Spike: 0.01N NaCl (sodium chloride) standard solution
3.3 Titrant: 0.01N $AgNO_3$ (silver nitrate) standard solution
3.4 Mixing/Cleansing: Deionized (D.I.) water
3.5 Electrolyte: 2M KNO_3 (potassium nitrate) for electrode

3.6 CAUTION! The laboratory technicians performing these tests will be handling concentrated HNO_3 and other hazardous materials. All sample digestion procedures should be performed under an exhaust hood. Prior to initiating the following procedures, it is imperative that all persons involved with this testing be outfitted with rubber or latex gloves, heat resistant gloves, rubber aprons, safety glasses and any other safety devices deemed necessary. It is of utmost importance for the technicians handling these chemicals to understand the potential hazards associated with them. READ THE M.S.D.S. SHEETS FOR THE ABOVE REAGENTS! (See Appendix E).

4. Sample Preparation:

4.1 Prior to beginning sample preparation, make sure the sample data (i.e., project name, project number, and grid location) is clearly documented and cross referenced to the sample I.D. number which will be used for the titration. If information is missing or unclear, contact the Research and Development Supervisor immediately.

4.2 Oven dry the samples in a 100^0C oven to a constant weight, with the covers removed. Weigh every 15 minutes. Pass a magnet through the samples. The magnet should be powerful enough to pick up any magnetic material in the sample. Be sure to brush off the magnet with a small paint brush between samples to prevent contamination of the samples.

4.3 Sieve the sample through a 0.300 mm sieve, collecting the sample in the sieve pan. Use a mortar and pestle to pulverize the portion of the sample retained on the sieve. Repeat the pulverization process until all of the sample passes the 0.300 mm sieve. Transfer the sample from the sieve pan to the original sample tin. Use a paint brush and compressed air to clean the sieve, pan, mortar and pestle between samples to prevent contamination of the samples.

4.4 Using a metal laboratory spatula, stir the sample to achieve a homogenous mixture. Tare a clean 100 ml beaker on the balance, then place 3.000 grams of prepared material in the beaker and weigh it to the nearest 0.001 gram. Wipe the spatula clean between samples.

Note: Samples should be prepared and tested in batches. It is suggested that batches of ten (10) samples be prepared.

5. Sample Digestion

5.1 All sample digestion procedures are to be completed under an exhaust hood.

5.2 Wearing latex gloves, dispense 50 ml of HNO_3 into a clean 100 ml beaker. Transfer the HNO_3 from the beaker into a clean burette.

5.3 Place 750 ml of D.I. water in a 1000 ml beaker and heat it on a hot plate to boiling.

5.4 Add 10 ml of hot D.I. water to the sample and swirl it into suspension with a glass stirring rod.

5.5 Dispense 3 ml of HNO_3 via burette into the sample. Stir the solution with a stirring rod until the acid is evenly distributed throughout the sample.

5.6 Add 15 ml of hot D.I. water to the sample and stir. Place the beaker with the sample onto a hot plate and boil for approximately 90 seconds*, stirring continually. Remove the beaker from the hot plate, using heat resistant gloves, and let the solids settle for a few seconds. Pour off the liquid into a glass titration vessel taking precaution to retain the solids in the beaker.

5.7 Pour an additional 15 ml of hot D.I. water into the beaker and again stir the solids into suspension. Boil the solution on a hot plate for 60 seconds*, stirring continually. Remove the beaker from the hot plate, using heat resistant gloves, and pour the entire contents of the beaker into the same glass titration vessel used in Step 5.6. Rinse the beaker with D.I. water (to remove residual solids from the sides of the beaker) into a glass titration vessel. The total sample volume should be approximately 60-70 ml (about 2/3 full).

*NOTE: If splashing of the sample due to hard boiling occurs prior to the completion of the recommended boiling period, remove the beaker from the heat immediately, using heat resistant gloves. Splashing of the sample from the beaker may cause loss of accuracy in test results.

6. Spike

6.1 For each day that chloride ion content testing is performed, a standard "spike" sample will be prepared. The spike is a known quantity of NaCl in solution. A similar spike will be added to each sample in order to insure that the titrator will find chloride in the sample. This amount, measured in ppm Cl, is then subtracted from the test result for the sample. The remainder is the chloride content of the sample itself.

6.2 Pour approximately 50 ml of 0.01N NaCl spike solution into a second burette.

6.3 Dispense 4 ml of 0.01N NaCl spike solution into a glass titration vessel via burette. Extreme care should be taken to ensure the accuracy of this step. For each 0.1 ml deviation from the prescribed dosage of 4 ml, a twelve (12) ppm difference in the final test result will occur. Add D.I. water to the vessel to a total volume of 60-70 ml (about 2/3 full).

6.4 Add to each prepared sample a 4 ml spike of the same 0.01 NaCl solution via burette. It is imperative that the same accuracy be exercised as in Step 6.3 above.

6.5 See Appendix C for the 0.01N NaCl spike calculations.

7. Preliminary Mettler DL25 Equipment Check:

7.1 **Electrode.** Before switching the unit on, visually check the level of clear fluid in the electrode. The level should be approximately 1 cm below the fill opening on the side of the electrode. If the level is deficient, remove the fill cap and add the appropriate amount of 2M KNO_3 (potassium nitrate) solution via syringe. The fill cap should remain open during chloride testing. See Appendix D for the manufacturer's recommended electrode maintenance procedures.

7.2 **Titrant.** Check the level of 0.01N $AgNO_3$ (silver nitrate) titrant in the brown glass bottle. The bottle should be at least half full. If more titrant is needed, contact the Chemist.

7.3 **Date.** Switch the DL25 unit on via the power strip. The Mettler DL25 titrator will prompt for the date. Enter the month (i.e., 1-12) then press **RUN**. Enter the day of the month (i.e., 1-31) followed by **RUN**. Enter the last two digits of the year (i.e., 95) followed by **RUN**. The date is now stored in the unit.

7.4 **Head Preparation.** Fill the white pump bottle with D.I. water. This is the rinsing unit for the Mettler DL25 titrator. Remove the plastic vessel used for the pH 4 buffer solution by loosening the collar and lowering the vessel until it clears the propeller and electrode (this area is hereafter referred to as the "head"). Store the vessel in a safe location, as it will be replaced onto the unit (Step 10.3) at the conclusion of the day's titration session. Place a 500 ml beaker under the head unit and wash the head using the white pump bottle. Usually 5-6 depresses of the pump are needed to cleanse the head. Remove the beaker. Wipe the propeller, electrode, and titrant tube with a paper towel to remove any water and contaminants that may remain after rinsing.

7.5 **Removing Air Bubbles.** If the unit is not used for prolonged periods of time, air bubbles may appear in the titrant burette and lines. These air bubbles need to be purged from the system in order to achieve precise dispensing of the titrant and accurate test results. If air bubbles have formed in the burette, remove the burette from the unit and hold it upside down. Remove the stopper from the burette and pour the titrant from the burette into a 500 ml beaker. Wipe the inside of the burette and the stopper with a clean, dry cloth and replace stopper. Place the burette assembly back onto the Mettler DL25 titrator. With the beaker still under the head unit, press the **BURET mL** button. This will actuate the stopper and push the titrant from the burette into the line leading to the head unit on its way up, and draw titrant from the brown titrant storage bottle on its way down. Since there is no titrant in the burette due to the above cleaning procedure, the BURET mL button may need to be utilized more than once to ensure a complete filling of the burette and lines. During this process it may be necessary to tap the lines in order to dislodge air bubbles from them. Cleanse the head as in 7.4.

8. Titration Of Standard Spike and Prepared Samples

8.1 Place the glass titration vessel with the spike and D.I. water onto the head of the titrator. Hand tighten the collar retaining ring to hold the vessel in place.

8.2 Press **RUN** to start the titration data entry process. The titrator will now prompt for sample weight. Since the initial powdered sample weight was 3.000 grams, enter 3.000 and press **RUN**. The titrator will then prompt for I.D. Enter the I.D. number that corresponds to the sample being tested. Check the sample log book for this information. Follow this entry with **RUN**. The prompt will indicate "Busy." This allows the operator to pause before the titration begins.

8.3 If an error in data entry was made, the process can be halted by pressing **RESET**. If this is done, advance the printer paper to the next full sheet of paper and repeat Step 8.2. Press **RUN** a fourth time to start the titration process.

8.4 The titrator is now testing the standard spike sample for total chloride content. The result will be reported in parts per million (ppm). The result will display on the titrator and a plot of data will be printed. Upon completion of each titration, the titrator will sound three (3) times. The glass titration vessel can now be removed and its contents poured into the 500 ml beaker used in Step 7.5. With the vessel removed, place the beaker under the head and cleanse via pump. Wipe the head dry.

8.5 Write the test result in the sample log book under the heading of "ppm spike". This result should be about 473 ppm for the spike. If there is a deviation of 15 ppm or more, run the spike again. The spike can change due to evaporation of water, thus resulting in slightly increasing concentrations of spike. The spike needs to be checked prior to each day's titration session.

8.6 Repeat Steps 8.1 - 8.4 for the prepared samples. Write these test results in the sample log book under the heading of "ppm found". Subtract the "ppm spike" result from the "ppm found" result to find the chloride content of the samples. Enter this remainder in the corresponding row under the heading "ppm sample".

9. Disposal Of Chemicals

9.1 DO NOT FLUSH CHEMICALS DOWN THE SINK. Excess reagents are not to be poured back into their original containers. Excess reagents are to be stored in individual glass bottles as follows for proper disposal via the chemist:

HNO_3: excess chemical in labelled glass container.
$AgNO_3$: excess chemical, precipitant from titration and rinse water in labelled glass container.
KNO_3: contact chemist as to proper disposal.
NaCl: excess chemical can be flushed down the sink - non hazardous.

10. Cleaning

10.1 Switch the titrator off via the power strip. Make sure there is enough paper in the printer and sufficient reagents for the next round of chloride tests.

10.2 All glassware (i.e., beakers, vessels, stirring rods, burettes, etc.) are to be washed with hot water and laboratory soap, rinsed with D.I. water, and air dried on paper towels.

10.3 When the unit is not in use, the fill cap should be closed on the Mettler DM 141-SC electrode. The electrode should be immersed in a pH 4 buffer solution (The buffer solution is contained in the plastic titration vessel that was removed from the titrator in Step 7.4 above).

State of Vermont
Agency of Transportation
Materials & Research Section

VT AOT MRD 48-97

Prepared by: Tracy Phillips, Chemist
Date prepared: 08/14/97

CALCIUM OXIDE

References:
Standard Specification for Transportation Materials and Methods of Sampling And Testing, Seventeenth Edition, 1995, Part II. AASHTO Designation: T 105-91, section thirteen.

Principle: In this test method manganese is removed from the filtrate after the determination of SiO_2 and the ammonium hydroxide group. Calcium is then precipitated as the oxalate is redissolved and titrated with potassium permanganate ($KMnO_4$).

SAFETY CONSIDERATIONS FOR THE FOLLOWING TEST PROCEDURE

All testing must be performed under the fume hood. Acid resistant gloves must be worn when working with acid and base chemicals. Nitrile gloves must be worn at all times when working with any other chemicals in the chemistry lab. Eye protection and a lab coat are also required when performing chemical testing. Please refer to appendix A of this ("Chemistry Test Procedures") binder, prior to performing any test.

Reagents:

Ammonium Chloride (NH_4Cl)---This is a hazardous reagent - use the proper precautions when handling.

Ammonium Hydroxide 1:1 (NH_4OH)--Mix 100 mls of Ammonium Hydroxide with 100 mls of deionized water.This is a hazardous reagent - use the proper precautions when handling.

Ammonium Oxalate Solution--Mix 25 grams of Ammonium Oxalate with 500 mls of deionized water. This is a hazardous reagent - use the proper precautions when handling.

Ammonium Nitrate (NH_4NO_3)--Mix 20 grams of Ammonium Nitrate with 1 L of deionized water. This is a hazardous reagent - use the proper precautions when handling.

Concentrated Nitric Acid(HNO_3)--This is a hazardous reagent - use the proper precautions when handling and store below eye level.

Deionized Water (H_2O)

Concentrated Hydrochloric Acid (HCL)-This is a hazardous reagent - use the proper precautions when handling and store below eye level.

Hydrochloric Acid 1:2--Mix 100 mls of concentrated Hydrochloric Acid with 200 mls deionized water, (add acid to water). This is a hazardous reagent - use the proper precautions when handling and store below eye level.

Hydrochloric Acid 1:99--Mix 5 mls of concentrated Hydrochloric acid with 495 mls of deionized water, (add acid to water). Use hood goggles and lab coat. Stable 1 year at room temperature. This is a hazardous reagent - use the proper precautions when handling and store below eye level.

11) Place the filtrate from step 10 on the hot plate under the hood, add deionized H2O to reach a volume of 200mls. Add 10-15 mls of concentrated HCL.
12) Add 3 to 4 drops of Methyl red indicator and heat to boiling.
13) Add 1:1 NH4OH drop wise until the color of the solution becomes distinctly yellow, and add one drop in excess. A reddish brown precipitate will be formed, (which is the FeO3 and Al being removed). See note A.
14) Digest the solution containing the precipitate for 10 minutes on low heat. Remove from heat and allow the precipitate to settle--not more than 5 minutes!.
15) Prepare the funnels with #40 ashfree whatman filter paper.
16) Filter the solution into a 600ml beaker, keeping the filter paper nearly full during the filtering. Hold the rubber policeman at the spout while pouring and catch any drops from falling out. Also, avoid splashing!.
17) Allow precipitate to drain through funnel. Then without delay wash 3 times with hot NH4NO3 (with a volume of approximately 10mls) into the receiving beaker.

NOTE: Add two drops of Methyl red indicator to the wash bottle containing the NH4NO3, followed by 1:1 NH4OH dropwise until the color just changes to yellow. If the color reverts to red at any time, due to heating, it should be brought back to yellow by adding more 1:1 NH4OH.

18) Set the filtrate aside.
19) Transfer the precipitate and the filter paper to the same beaker which the precipitate was first derived.
20) Dissolve the precipitate with 10 mls hot 1:2 HCl. Stir throughly, macerate the paper, dilute the solution to about 100 mls with hot deionized H2O and place on the hot plate. AVOID BUMPING!
21) Precipatate the hydroxide as in steps 12-16. Use the 600ml beaker containing the filtrate reserved in step 18 as the receiver.
22) Wash the precipitate with four 10ml portions of hot NH4NO3. Rinse funnel one more time after the filter paper is removed. Reserve the filter paper for the determination of Ammonium Hydroxide Group.
23) Neutralize the filtrate with HCl to the Methyl red endpoint. Make just acid , then add 6 drops of HCl in excess. If manganese is present in the sample, see note B.
24) Evaporate or dilute the filtrate to 200 mls if necessary.

NOTE: It is acceptable to allow the components of these test to set overnight at this point. Save all funnels and beakers for steps to follow.

25) Add 5mls of HCl, 30mls of Ammonium Oxalate ((NH4)2 C2 O4) 50g/L.
26) Heat solution to 70-80'.
27) Add 1:1 NH4OH dropwise until color changes from red to yellow. See note C.
28) Let solution stand 1 hour without heat, stir occasionally for the first 30 minutes.
29) Prepare the funnels with #42 ashfree whatman filter paper. Wash into a 600ml beaker.

B. If Manganese is present insert the following steps:

a) Evaporate to a volume of 100ml. Add 40 mls of saturated Bromine water to the hot solution and immediately add NH4OH until the solution is distinctly alkaline (yellow). (The addition of 10mls NH4OH is usually sufficient).

b) Put a piece of filter paper (1cm'2) in the heal of the beaker and hold it down with a stirring rod to prevent bumping.

c) Boil the solution for 5 minutes or more making certain that the solution remains alkaline. If the precipitate (MnO) does not appear, allow a settling period of 1 hour before filtration. If precipitate appears proceed to steps d, and e, otherwise to f.

d) Filter the solution, wash with hot H2O. (Use #40 filter paper).

e) Discard the MnO precipitate.

f) Acidify the filtrate with HCL using litmus paper as the indicator. Boil until all Br2 is expelled.

g) Add a few drops of methyl red.

C. This neutralization must be made slowly, otherwise precipitated calcium oxalate may have a tendency to run through the filter paper. When a number of these determinations are being made simultaneously, the following technique will assist in ensuring slow neutralization. Add two or three drops of NH4OH to the first beaker while stirring, then 2 or 3 drops tho the second, and so on, returning to the first beaker to add 2 or 3 more drops, ect., until the indicator color has changed in each beaker.

D. If the addition of KMnO4 is too rapid, some MnO2 will be produced in addition to Mn2+. Evidence for this is a faint brown discoloration of the solution. This is not a serious problem as long as sufficient oxalate remains to reduce the MnO2 to Mn2+; the titration is temporarily discontinued until the solution clears. The solution must be free of MnO2 at the equivalence point.

OTHER NOTES:

1. To measure the volume of KMnO4, take the surface of the liquid as a point of reference. Alternatively, provide sufficient blacklight with a flashlight to permit reading of the meniscus in the conventional manner.
2. Permanganate solutions should not be allowed to stand in burets any longer than necessary, as decomposition to MnO2 may occur. Freshly formed MnO2 can be removed from burets and glassware with a warm cleaning solution, prepared as follows. Add 30 mls of H2SO4 to a 200ml bottle and dilute to volume with Ammonium Oxalate solution prepared earlier for this procedure, equals a 3 molar solution.
3. Any KMnO4 spattered on the sides of the titration vessel should be washed down immediately with a stream of water.
4. Rinse titrator with KMnO4 prior to use, if air bubbles are present jolt titrator to release them. This CaO should be titrated with approximately 35 mls.

State of Vermont
Agency of Transportation
Materials & Research Section

VTAOT MRD 49-97

Prepared By: Tracy Phillips, Chemist
Date prepared: 08/13/97

INSOLUBLE RESIDUE

References:
Standard Specification for Transportation Materials and Methods of Sampling And Testing, Seventeenth Edition, 1995, Part II. AASHTO Designation: T 105-91, section five.

Principle: In this procedure, insoluble residue of a cement is determined by digestion of the sample in hydrochloric acid followed, after filtration, by further digestion in sodium hydroxide. The resulting residue is ignited and weighed.

SAFETY CONSIDERATIONS FOR THE FOLLOWING TEST PROCEDURE

All testing must be performed under the fume hood. Acid resistant gloves must be worn when working with acid and base chemicals. Nitrile gloves must be worn at all times when working with any other chemicals in the chemistry lab. Heat resistant gloves must be worn when using the muffle furnace or handling hot crucibles. Eye protection and a lab coat are also required when performing chemical testing. Please refer to appendix A of this ("Chemistry Test Procedures") binder, prior to performing any test.

Reagents:
Ammonium Nitrate (NH4NO3)--Mix 20 grams of Ammonium Nitrate with 1 L of deionized water. This is a hazardous reagent - use the proper precautions when handling.
Deionized Water (H2O)
Concentrated Hydrochloric Acid (HCL)-This is a hazardous reagent - use the proper precaution when handling and store below eye level.
Methyl Red Indicator--Prepare the solution by adding 0.50g of methyl red indicator to 250 mls of 95% ethyl alcohol. -This is a hazardous reagent - use the proper precautions when handling.
Sodium *Hydroxide (NaOH)*--Add 5 grams of Sodium Hydroxide to 500 mls of deionized water. This is a hazardous reagent - use the proper precautions when handling.

Procedure:
1) Weigh sample to 1.0000g in a 250ml beaker. Prepare a blank and a control sample, following the same procedure and using the same amounts of reagents.
2) Add 25 mls of deionized water followed quickly with 5mls of concentrated HCl.
3) Cover mixture with a watch glass. Put on hot plate and heat to dissolve.
4) Dilute solution with hot deionized H20 to 50mls.
5) Bring to near boiling on high temperature hot plate.
6) Digest for 15min.
7) Filter through Whatman #40 filter paper. Wash thoroughly with hot deionized water.
8) Collect approximately 200mls of filtrate in a 600ml beaker--SAVE FOR SO3.
9) Transfer filter paper back to original 250ml beaker.
10) Add 100mls (room temp) NaOH to filter paper in 250ml beaker, and place on hot plate to dissolve SiO2.
11) Digest sample on the hot plate for 15 min., and macerate during digestion.

State of Vermont
Agency of Transportation
Materials and Research Section

VT AOT MRD 50-97

Prepared by: Tracy Phillips
Date Prepared: 08/14/97

References:
Standard Specification for Transportation Materials and Methods of Sampling And Testing, Seventeenth Edition, 1995, Part II. AASHTO Designation: T 105-91, section sixteen.

Principle:
In this test method the cement is ignited in a muffle furnace at a controlled temperature. The loss is assumed to represent the total moisture and CO2 in the cement.

SAFETY CONSIDERATIONS FOR THE FOLLOWING TEST PROCEDURE

Heat resistant gloves must be worn when using the muffle furnace or handling hot crucibles.

LOSS ON IGNITION

Procedure:

1. Place platinum crucible in a desiccator for 15 minutes.
2. Weigh platinum crucibles, and record.
3. Ignite furnace at 950+/-50'C.
4. Weigh in tared platinum crucibles 1g of sample, add to initial weight and record.
5. Cover and ignite to a constant weight (roughly 11/2 hours).
6. Cool crucibles on ceramic plate for 5 minutes.
7. Place in a desiccator for 15 minutes.
8. Weigh and record the weights of the crucibles on the analytical balance.

Calculation:

Multiple the loss in weight in grams by 100, and report to the nearest tenth.

State of Vermont
Agency of Transportation
Materials & Research Section

VT AOT MRD 51-97

Prepared by: Tracy Phillips, Chemist
Date prepared: 08/14/97

MAGNESIUM OXIDE

References:
Standard Specification for Transportation Materials and Methods of Sampling And Testing, Seventeenth Edition, 1995, Part II. AASHTO Designation: T 105-91, section fourteen.

Principle: In this test method manganese is precipitated as magnesium ammonium phosphate from the filtrate after the removal of calcium. The precipitate is ignited and weighed as magnesium pyrophosphate ($Mg_2P_2O_7$). The MgO equivalent is then calculated.

SAFETY CONSIDERATIONS FOR THE FOLLOWING TEST PROCEDURE

All testing must be performed under the fume hood. Acid resistant gloves must be worn when working with acid and base chemicals. Nitrile gloves must be worn at all times when working with any other chemicals in the chemistry lab. Heat resistant gloves must be worn when using the muffle furnace or handling hot crucibles. Eye protection and a lab coat are also required when performing chemical testing. Please refer to appendix A of this ("Chemistry Test Procedures") binder, prior to performing any test.

Reagents:

Ammonium Chloride (NH_4Cl)---This is a hazardous reagent - use the proper precautions when handling.

Ammonium Hydroxide (NH_4OH)--This is a hazardous reagent - use the proper precautions when handling and store below eye level.

Ammonium Hydroxide 1:1 (NH_4OH)--Mix 100 mls of Ammonium Hydroxide with 100 mls of deionized water. This is a hazardous reagent - use the proper precautions and store below eye level.

Ammonium Hydroxide 1:20 (NH_4OH)--Mix 20 mls of Ammonium Hydroxide with 380 mls of deionized water. This is a hazardous reagent - use the proper precautions when handling, and store below eye level.

Ammonium Oxalate Solution--Mix 25 grams of Ammonium Oxalate with 500 mls of deionized water. This is a hazardous reagent - use the proper precautions when handling.

Ammonium Nitrate (NH_4NO_3)--Mix 20 grams of Ammonium Nitrate with 1 L of deionized water. This is a hazardous reagent - use the proper precautions when handling.

Ammonium Phosphate dibasic ($(NH_4)_2PO_4$)--Mix 50 grams of Ammonium Phosphate dibasic with 500 mls of deionized water. This is a hazardous reagent - use the proper precautions when handling.

14) Digest the solution containing the precipitate for 10 minutes on low heat. Remove from heat and allow the precipitate to settle--not more than 5 minutes!.
15) Prepare the funnels with #40 ashfree whatman filter paper.
16) Filter the solution into a 600ml beaker, keeping the filter paper nearly full during the filtering. Hold the rubber policeman at the spout while pouring and catch any drops from falling out. Also, avoid splashing!.
17) Allow precipitate to drain through funnel. Then without delay wash 3 times with hot NH4NO3 (with a volume of approximately 10mls) into the receiving beaker.

NOTE: Add two drops of Methyl red indicator to the wash bottle containing the NH4NO3, followed by 1:1 NH4OH dropwise until the color just changes to yellow. If the color reverts to red at any time, due to heating, it should be brought back to yellow by adding more 1:1 NH4OH.

18) Set the filtrate aside.
19) Transfer the precipitate and the filter paper to the same beaker which the precipitate was first derived.
20) Dissolve the precipitate with 10 mls hot 1:2 HCl. Stir throughly, macerate the paper, dilute the solution to about 100 mls with hot deionized H2O and place on the hot plate. AVOID BUMPING!
21) Precipitate the hydroxide as in steps 12-16. Use the 600ml beaker containing the filtrate reserved in step 18 as the receiver.
22) Wash the precipitate with four 10ml portions of hot NH4NO3. Rinse funnel one more time after the filter paper is removed. Reserve the filter paper for the determination of Ammonium Hydroxide Group.
23) Neutralize the filtrate with HCl to the Methyl red endpoint. Make just acid , then add 6 drops of HCl in excess. If manganese is present in the sample, see note B.
24) Evaporate or dilute the filtrate to 200 mls if necessary.

NOTE: It is acceptable to allow the components of these test to set overnight at this point. Save all funnels and beakers for steps to follow.

25) Add 5mls of HCl, 30mls of Ammonium Oxalate.
26) Heat solution to 70-80'.
27) Add 1:1 NH4OH dropwise until color changes from red to yellow. See note C.
28) Let solution stand 1 hour without heat, stir occasionally for the first 30 minutes.
29) Prepare the funnels with #42 ashfree whatman filter paper. Wash into 600ml beakers.
30) Wash the precipitate 8 to 10 times with hot deionized H2O as follows, rinse the beaker 4 times and the funnel 4 times. The total wash water should not exceed 75mls!. During washing, H2O from the wash bottle should be directed around the inside of the filter paper to wash the precipitate down, then a jet of H2O should be gently directed toward the center of the paper in order to agitate and throughly wash the precipitate.
31) Acidify the filtrate with HCl and proceed with the determination of Magnesium Oxide.
32) Reserve the precipitate and filter paper for the determination of CaO
33) Evaporate by boiling to about 250mls.
34) Cool the solution to room temperature.

c) Boil the solution for 5 minutes or more making certain that the solution remains alkaline. If the precipitate (MnO) does not appear, allow a settling period of 1 hour before filtration. If precipitate appears proceed to steps d, and e, otherwise to f.

d) Filter the solution, wash with hot H2O. (Use #40 filter paper).

e) Discard the MnO precipitate.

f) Acidify the filtrate with HCL using litmus paper as the indicator. Boil until all Br2 is expelled.

g) Add a few drops of methyl red.

C. This neutralization must be made slowly, otherwise precipitated calcium oxalate may have a tendency to run through the filter paper. When a number of these determinations are being made simultaneously, the following technique will assist in ensuring slow neutralization. Add two or three drops of NH4OH to the first beaker while stirring, then 2 or 3 drops tho the second, and so on, returning to the first beaker to add 2 or 3 more drops, ect., until the indicator color has changed in each beaker.

D. Extreme caution should be exercised during this ignition. Reduction of the phosphate precipitate can result if carbon is in contact with it at high temperatures. There is also danger of occluding carbon in the precipitate if ignition is too rapid.

State of Vermont
Agency of Transportation
Materials & Research Section

VT AOT MRD 52 - 97

Prepared by: Tracy Phillips, Chemist
Date prepared: 08/13/97

References:
Standard Specification for Transportation Materials and Methods of Sampling And Testing, Seventeenth Edition, 1995, Part II. AASHTO Designation: T 105-91, section six.

SILICON DIOXIDE IN PORTLAND CEMENT

Principal: In this test method silicon dioxide ($SiO2$) is determined gravimetrically. Ammonium chloride is added and the solution is not evaporated to dryness.

SAFETY CONSIDERATIONS FOR THE FOLLOWING TEST PROCEDURE

All testing must be performed under the fume hood. Acid resistant gloves must be worn when working with acid and base chemicals. Nitrile gloves must be worn at all times when working with any other chemicals in the chemistry lab. Heat resistant gloves must be worn when using the muffle furnace or handling hot crucibles. Eye protection and a lab coat are also required when performing chemical testing. Please refer to appendix A of this ("Chemistry Test Procedures") binder, prior to performing any test.

Reagents:

Ammonium Chloride (NH4Cl)---This is a hazardous reagent - use the proper precautions when handling.

Concentrated Nitric Acid(HNO3)--This is a hazardous reagent - use the proper precautions when handling and store below eye level.

Deionized Water (H2O)

Concentrated Hydrochloric Acid (HCL)-This is a hazardous reagent - use the proper precautions when handling and store below eye level.

Hydrochloric Acid 1:99--Mix 5ml of concentrated Hydrochloric acid with 495 mls of deionized H2O, (add acid to water). Use hood goggles and lab coat. Stable 1 year at room temperature. This is a hazardous reagent - use the proper precautions when handling and store below eye level.

Procedure:

1) Weigh 0.5g of cement into a 50ml beaker. Prepare a blank and a control sample, following the same procedure and using the same amounts of reagents.
2) Add 0.5g of NH4Cl, and cover preparation with a watch glass.

State of Vermont
Agency of Transportation
Materials & Research Section

VT AOT MRD 53-97

Prepared by: Tracy Phillips, Chemist
Date Prepared: 08/14/97

References:
Standard Specification for Transportation Materials and Methods of Sampling And Testing, Seventeenth Edition, 1995, Part II. AASHTO Designation: T 105-91, section fifteen.

SULFUR TRIOXIDE

Principle: In this test method, sulfate is precipitated from an acid solution of the cement with barium chloride (BaCl2). The precipitate is ignited and weighed as barium sulfate (BaSO4) and the SO3 equivalent is calculated.

SAFETY CONSIDERATIONS FOR THE FOLLOWING TEST PROCEDURE

All testing must be performed under the fume hood. Acid resistant gloves must be worn when working with acid and base chemicals. Nitrile gloves must be worn at all times when working with any other chemicals in the chemistry lab. Heat resistant gloves must be worn when using the muffle furnace or handling hot crucibles. Eye protection and a lab coat are also required when performing chemical testing. Please refer to appendix A of this ("Chemistry Test Procedures") binder, prior to performing any test.

Reagents:
Ammonium Nitrate (NH4NO3)--Mix 20 grams of Ammonium Nitrate with 1 L of deionized water. This is a hazardous reagent - use the proper precautions when handling.
Barium Chloride--Mix 50 grams of Barium Chloride to 500 mls of deionized H20. This is a hazardous reagent - use the proper precautions when handling.
Deionized Water (H2O)
Concentrated Hydrochloric Acid (HCL)-This is a hazardous reagent - use the proper precautions when handling and store below eye level.
Methyl Red Indicator--Prepare the solution by adding 0.50g of methyl red indicator to 250 mls of 95% ethyl alcohol. -This is a hazardous reagent - use the proper precautions when handling.
Sodium Hydroxide (NaOH)--Add 5 grams of Sodium Hydroxide to 500 mls of deionized water. This is a hazardous reagent - use the proper precautions when handling.

November 28, 2006 (Revised 3/12/09)

3/12/2009

State of Vermont
Agency of Transportation
Materials and Research Section
VT AOT – MRD 54-09

VERMONT STANDARD PROCEDURE OF TARGET DENSITY DETERMINATION FOR SUBBASE COMPACTION CONTROL

1. SCOPE

1.1. This method of test is intended for use in determining the target density and moisture content for compaction control of Subbase placed on Agency projects.

1.2. It is intended to be used in conjunction with AASHTO test method T 180, Method D.

1.3. Material retained on the 1½ inch sieve shall be considered oversize particles for the purposes of this test method.

1.4. A 6 inch mold (Method D) shall be considered standard.

2. REFERENCE DOCUMENTS

2.1. AASHTO Designation T 27, Sieve Analysis of Coarse and Fine Aggregates

2.2. AASHTO Designation T 180, Moisture-Density Relationships of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

2.3. AASHTO Designation T 224, Correction for Coarse Particles in the Soil Compaction Test.

2.4. Vermont Agency of Transportation 2006 Standard Specifications for Construction.

3. APPARATUS

3.1. The apparatus shall be as described in AASHTO T 180.

4. PROCEDURE

4.1. Sieve an adequate quantity of a representative sample of the aggregate over an 1½ inch sieve. Discard the coarse material, if any, retained on the 1½ inch sieve.

4.2. Follow the procedure outlined in Method D of AASHTO T 180 to determine the maximum dry density of the material. Continue the series of determinations until there is either a decrease or no change in the wet unit mass per cubic foot of the compacted aggregate.

4.3. The test shall be repeated a minimum three times until the standard error of the mean maximum dry density is less than 1 pound per cubic foot. No more than 10 replications of the test will be required.

5. CALCULATIONS

5.1. Calculate the moisture contents and determine the maximum dry density in accordance with AASHTO T 180. Correction for discarded material retained on the 1½ inch sieve shall be conducted in accordance with AASHTO T 224.

5.2. Calculate the standard error of the mean dry density as follows:

$$se = \frac{s}{\sqrt{n}}$$

where:

$se =$ standard error

$s =$ standard deviation $= \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(x-\overline{x}\right)^2}$

$n =$ number of sample values

$x =$ individual sample value

$\overline{x} =$ sample average

5.3. Example 1; testing yields the following maximum dry density results in pcf: 140.9, 139.5, 136.5

$\overline{x} = 139.0$
$s = 2.25$
$n = 3$
$se = 1.30$

Since 1.30 is greater than 1.0, continue testing until *se* is less than 1.0 or until 10 tests have been completed, whichever occurs first.

5.4. Example 2; testing yields the following maximum dry density results in pcf: 140.9, 139.5, 136.5, 137.9

$\overline{x} = 138.7$
$s = 1.91$
$n = 4$
$se = 0.96$

Since 0.96 is less than 1.0, testing is complete.

5.5. Multiply the average corrected maximum dry density by 95% (0.95) to achieve target density for construction compaction control.

6. REPORT

6.1. The report shall include the following:
- 6.1.1. The moisture-density curves for the individual test replications;
- 6.1.2. Sample gradation and percent of the material retained on the 1½ inch sieve;
- 6.1.3. Standard error calculations and results; and
- 6.1.4. The target maximum dry density and optimum moisture content.

Corrected Copy No.: ______

Date: ______

Vermont Agency of Transportation
Materials & Research Section

DISTRIBUTION

Res. Eng. ______

Others ______

STANDARD ERROR
WORKSHEET

VT AOT - MRD 54-09

Project Name & Number: ______________________

Material Source: ______________________

Pay Item Number & Name: ______________________

Material Spec. Number & Name: ______________________

Fill in the individual sample value, x, where indicated.

A minimum of three samples are required and if the standard error is ≥1.00 additional samples will be required.

Note: All values are tested and reported in pcf.

Minimum of 3 Samples Required						
	n	w	x	$\bar{x}$	s	se
	1			------	------	--------
	2			------	------	--------
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					

n = Number of sample values

w = Optimum Moisture Content

x = Individual sample value

$\bar{x}$ = Sample average

s = Standard deviation

$$s\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}$$

se = Standard error

$$se = \frac{s}{\sqrt{n}}$$

Reviewed by: ______________________ Date: ______

Vermont Agency of Transportation
Materials & Research Section

DISTRIBUTION
Res. Eng. ____________
Others ____________

Lab ID: ____________________

LAB TO FIELD
STONE CORRECTION

AASHTO T-224

Project Name & Number: ____________________

Material Source: ____________________

Pay Item Number & Name: ____________________

Material Spec. Number & Name: ____________________

Sampled By: ____________________ Sample Date: ____________

Tested By: ____________________ Date Tested: ____________

Calculate the corrected Optimum Moisture

@ Assumed 2% moisture for material retained on required sieve

A) Optimum Moisture (Example: 4.1% then use 0.041)	
B) % of material passing required sieve (Example: 77.0% then use 77.0)	
C) @Assumed % moisture of material retained on required sieve (Example: 2.0% then use 0.020)	
D) % of material retained on the required sieve (Example: 23.0% then use 23.0)	
E) (A x B) Opt Moist * percent passing required sieve	
F) (C x D) @Assumed % moisture of retained material * % retained material	
G) (E + F) **Corrected Optimum Moisture**	

Calculate the corrected Maximum Dry Density

1) 62.4 (known) x 2.65 (assumed Bulk Sp. Gr.) = 165.36 or (62.4 x actual Bulk Sp Gr)	
2) Maximum Dry Density (Example: 145.0)	
3) % of material retained on the required sieve (Example: 23.0% then use 23.0)	
4) % of material passing required sieve (Example: 77.0% then use 77.0)	
5) (2 x 3) Max Dry Density * % of retained material	
6) (1 x 4) Known * % of passing material	
7) (2 x 1) x 100 Max Dry Density * known * 100	
8) (5 + 6)	
9) (7 / 8) **Corrected Maximum Dry Density**	

State of Vermont
Agency of Transportation
Materials and Research Section
VT AOT – MRD 55-06

VERMONT STANDARD PROCEDURE FOR DETERMINATION OF SUBBASE COMPACTION

1. SCOPE

1.1. This method of test is intended for use in determining compliance with Subbase compaction specifications on Agency projects.
1.2. It is intended to be used in conjunction with AASHTO test method T 310.

2. REFERENCE DOCUMENTS

2.1. AASHTO Designation T 310, In-Place Density and Moisture Content of Soil and Soil-aggregate by Nuclear Methods (Shallow Depth)
2.2. Vermont Agency of Transportation MRD 54-06 Procedure of Target Density Determination For Subbase Compaction Control
2.3. Vermont Agency of Transportation 2006 Standard Specifications for Construction.

3. APPARATUS

3.1. The apparatus shall be as described in AASHTO T 310.

4. PROCEDURE

4.1. Prepare test site as indicated in AASHTO T310 section 9.4.6 to 9.4.10
4.2. Take an initial reading as described in AASHTO T310 section 9.4.11 to 9.4.15
4.3. Rotate the gauge about the axis of the probe to acquire three additional readings, taken 90° apart.
4.4. Repeat Procedure 4.1 to 4.3 in a new location if calculations determine that test readings are to be discarded

5. CALCULATIONS

5.1. Calculate the average of all four dry density readings when they are within 5 lb/ft^3. All four dry density readings will be used to determine the density at that location if all readings are within a 5 lb/ft^3 window.
5.2. Calculate the average of three readings when an extreme reading is more than 5 lb/ft^3 from the highest or lowest (whichever is appropriate) reading. The extreme reading is discarded and the density at that location will be determined by the remaining three readings.
5.3. If three readings cannot be taken within 5 lb/ft^3, then all readings are discarded and a new location will be tested.

5.4. Calculate the average moisture content by averaging the moisture contents that are applicable to the above dry density readings (from 5.1 or 5.2 above).

5.5. Determine if the average density reading (from 5.1 or 5.2 above) meets or exceeds the target dry density as determined by VT AOT- MRD 54-06 Procedure of Target Density Determination for Sub-base Compaction Control.

6. REPORT

6.1. The report shall include the following:

6.1.1. Test site identification/ Project name & number
6.1.2. Pay Item number and description
6.1.3. Test number
6.1.4. Date
6.1.5. Name of Acceptance/Independent Assurance personnel
6.1.6. Name of Project Representative
6.1.7. Depth of test(s)
6.1.8. Dry density readings from test locations
6.1.9. Moisture content readings from test locations
6.1.10. The target maximum dry density and optimum moisture content.
6.1.11. PASS/FAIL indication for compliance with target density

Vermont Agency of Transportation
VT AOT – MRD 55-06b
VERMONT SUBBASE FIELD COMPACTION (AASHTO 310)
INDEPENDENT ASSURANCE COMPARISON REPORT
Referenced VT AOT MRD 54-06

Project Name & No: ______________________________

Aggregate Source: ____________________ R.E.: ____________

Pay Item Name: ____________________ Pay Item #: ____________

Cross Reference Number: ____________________ Date: ____________

Acceptance Testing By: ____________________ Test Number: ____________

Station ____________ Offset ____________ Elevation: ____________

VT AOT – MRD 54-06 DATA:

Maximum Dry Density (lb/ft^3) ____________ Moisture Density Curve # ____________

Target Dry Density (lb/ft^3) ____________ Optimum Moisture (%) ____________

Acceptance Data

	A	B	C	D
In-Place Dry Density (lb/ft^3)				
In-Place Moisture (%)				

Ave. Dry Density lb/ft^3 **Average Moisture** **Compaction (%)**

Independent Assurance Data

	A	B	C	D
In-Place Dry Density (lb/ft^3)				
In-Place Moisture (%)				

Ave. Dry Density lb/ft^3 **Average Moisture** **Compaction (%)**

	I.A Sample	Accept. Sample	Difference	Maximum Variance	Outside Maximum Variance
Moisture (%)				**2%**	
Compaction (%)				**5%**	

Remarks: ______________________________

____

Reviewed By: C&IA Supervisor ____________

Quality Engineer ____________

cc: (1) M&R-I.A Tech, (2) Construction Section- R.C.E., R.E., R.M.L.

Prepared by Jerry McMahan and John Staab

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH SECTION
VT AOT – MRD 56

VERMONT STANDARD METHOD FOR DETERMINATION OF THE PRESENCE OF THE ANTI-CAKING AGENT YPS

1. Scope:

1.1. This method's intent is to determine the presence of the anti-caking agent YPS (sodium ferrocyanide, aka 'yellow prussiate of soda') in sodium chloride intended for use as a deicer. The color of the prepared sample is compared to that of standards of known concentration. This method is semi-quantitative and allows a visual estimate of YPS content to within approximately 5mg/kg.

1.2. The value will be reported, based on visual comparison with 20, 30, 40, 50 and 60mg/kg standards. 50mg/kg is the minimum allowed by our specification.

1.3. *This procedure involves hazardous materials and does not address the safety problems associated with their use. It is the responsibility of the user of this method to learn and follow appropriate safety and health practices. Before performing this test, the MSDS for each reagent must be read and understood. Precautions outlined in the Materials and Research Chemical Hygiene Plan and the Materials and Research PPE Plan must be adhered to when performing this or any other procedure at this laboratory.*

2. Reagents:

2.1. Sodium chloride, NaCl, ACS grade.

2.2. Sulfuric acid, concentrated, $H_2 SO_4$, ACS grade.

2.3. Sodium ferrocyanide ('YPS'), decahydrate, $Na_4Fe(CN)_6 \cdot 10\ H_2O$, ACS grade.

2.4. Ferrous sulfate, heptahydrate, $FeSO_4 \cdot 7H_2O$, ACS grade.

2.5. Deionized water, ASTM Type II or better.

3. Working Solutions:

3.1. Ferrous sulfate solution: In a 100ml volumetric flask, dissolve 5g of $FeSO_4 \cdot 7H_2O$ and 2ml of concentrated $H_2 SO_4$ in approximately 80ml of deionized water. Dilute to the 100ml mark and mix well. Make fresh reagent weekly, or more often if the solution acquires a yellow tint.

3.2. Sodium ferrocyanide stock solution, 250mg/l: In a 1000ml volumetric flask, dissolve 0.3982g of $Na_4Fe(CN)_6 \cdot 10\ H_2O$ in approximately 700ml of deionized water and fill to the 1000ml mark with water. Make fresh reagent monthly.

3.3. Sodium ferrocyanide color standard, 20ppm: In a 100ml volumetric flask, dissolve 25g sodium chloride, 5ml of ferrous sulfate solution and 2ml of the sodium ferrocyanide stock solution in approximately 75ml of deionized water. Dilute to 100ml and mix well. Allow at least 15 minutes for the color to develop fully. This standard will deteriorate over time. If it begins to assume a greenish hue, it should be discarded and remade.

3.4. Sodium ferrocyanide color standard, 30ppm: In a 100ml volumetric flask, dissolve 25g sodium chloride, 5ml of ferrous sulfate solution and 3ml of the sodium ferrocyanide stock solution in approximately 75ml of deionized water. Dilute to 100ml and mix well. Allow at least 15 minutes for the color to develop fully. This standard will deteriorate over time. If it begins to assume a greenish hue, it should be discarded and remade.

3.5 Sodium ferrocyanide color standard, 40ppm: In a 100ml volumetric flask, dissolve 25g sodium chloride, 5ml of ferrous sulfate solution and 4ml of the sodium ferrocyanide stock solution in approximately 75ml of deionized water. Dilute to 100ml and mix well. Allow at least 15 minutes for the color to develop fully. This standard will deteriorate over time. If it begins to assume a greenish hue, it should be discarded and remade.

3.6 Sodium ferrocyanide color standard, 50ppm: In a 100ml volumetric flask, dissolve 25g sodium chloride, 5ml of ferrous sulfate solution and 5ml of the sodium ferrocyanide stock solution in approximately 75ml of deionized water. Dilute to 100ml and mix well. Allow at least 15 minutes for the color to develop fully. This standard will deteriorate over time. If it begins to assume a greenish hue, it should be discarded and remade.

3.7 Sodium ferrocyanide color standard, 60ppm: In a 100ml volumetric flask, dissolve 25g sodium chloride, 5ml of ferrous sulfate solution and 6ml of the sodium ferrocyanide stock solution in approximately 75ml of deionized water. Dilute to 100ml and mix well. Allow at least 15 minutes for the color to develop fully. This standard will deteriorate over time. If it begins to assume a greenish hue, it should be discarded and remade.

4. Equipment:

4.1 Volumetric flasks, 100ml, 5 for reagent and standard preparation plus one flask for each sample to be tested.

4.2 Volumetric flask, 1000ml.

4.3 Analytical balance capable of reading to the nearest 0.0001g for preparing reagents and standards.

4.4 Balance capable of reading to the nearest 0.1g for weighing samples.

4.5 Whatman #1 quantitative filter paper or equivalent, 12.5cm.(Note: a tighter filter paper may be required if the liquid is cloudy after filtering).

4.6 A well lit bench top with a white background for viewing sample color.

4.7 Beakers, 100 to 250ml, one per sample.

4.8 Filter funnels, one per sample.

4.9 Sieves conforming to the requirement in AASHTO M 92.

4.10 A mill, grinder or similar device for pulverizing the sample.

5. Procedure:

5.1 Acquire a minimum 300g representative sample of the salt. Pulverize the entire sample until it has a homogeneous appearance and no coarse sand or larger size particles are visible. Mix the pulverized sample well to homogenize.

5.2 Dissolve 25g of pulverized sample in approximately 70ml of water in a beaker. Filter through a prewetted filter and collect the liquid in a 100ml volumetric flask. Rinse the filter with approximately 10ml of water.

5.3 Add 5ml of ferrous sulfate solution to the flask, dilute to the 100ml mark and mix well. Allow the color to develop for at least 15 minutes.

5.7 Compare the color of the sample with the previously prepared sodium ferrocyanide color standards and determine the approximate sodium ferrocyanide content of the sample. Be sure all samples and standards are well mixed before making the comparison. A white, well lit background will make comparison easier. Report YPS concentration to the nearest 5mg/kg.

Note 1: Well mixed samples and standards may be decanted into vials and viewed in a rack, in the manner that the color of maple syrup is evaluated. This may make comparison easier.

Note 2: The coarsest filter that produces a turbidity-free liquid should be used to filter the dissolved sample. Tight filters are much slower.

Note 3: If a spectrophotometer is available, this test may be made more quantitative by constructing an absorbance curve of color standards at 775nm and comparing sample absorbance to standard absorbance. To achieve this level of accuracy, the color standards must be made up fresh each time samples are tested. The quantitative range of the test may be expanded by measuring color standards at additional concentrations (a range of 0 - 100ppm is common).

6. Quality Control:

6.1 At least every 10 samples, or more frequently if the sample flow is small, duplicate samples should be analyzed to evaluate sampling and homogenizing procedures. Duplicate samples should not vary by more than 5mg/kg. If duplicate samples vary by more than 10mg/kg, a fresh sample should be sought for retesting and the test procedure should be evaluated.

7. References:

7.1 Maryland DOT, Colorimetric Determination of Sodium Ferrocyanide in Salt, MSMT 604.
7.2 Maine DOT, Method for the Colorimetric Determination of YPS in Rock Salt.
7.3 Robert O'Brian, handwritten notes on YPS, 1989.

Prepared by: Jerry McMahan
Date: November 25, 2009

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH SECTION

VERMONT STANDARD METHOD FOR DETERMINATION OF ACID-INSOLUBLE RESIDUE IN AGGREGATE

VT AOT – MRD 57-09

1. <u>Scope:</u>

1.1. This method's intent is to determine the acid-insoluble residue ('AIR') of aggregates used for bituminous concrete. A low AIR level may indicate increased susceptibility to polishing, which can result in inadequate friction between tires and the pavement surface. This method may also be used to evaluate aggregates used for other purposes, e.g. MSE wall backfill.

1.2. The value will be reported as percent by dry weight of acid-insoluble residue. An AIR greater than 20% is generally required of limestone or dolomite aggregates. Any aggregate with an AIR greater than 80% is defined as 'non-carbonate' aggregate. Specific project or mix formula AIR requirements may vary.

1.3. This procedure involves hazardous materials and does not address the safety problems associated with their use. It is the responsibility of the user of this method to learn and follow appropriate safety and health practices. Before *performing this test, the MSDS for each reagent must be read and understood. Precautions outlined in the Materials and Research Chemical Hygiene Plan and the Materials and Research PPE Plan must be adhered to when performing this or any other procedure at this laboratory.*

2. <u>Reagents:</u>

2.1. Hydrochloric acid (HCl), concentrated, ACS Grade.

2.2. Deionized water, ASTM Type II or better.

2.3. Potable tap water.

3. Working Solutions:

3.1. HCl, 1:3 solution: *In a fume hood,* carefully add 250ml of concentrated HCl to 750ml of deionized water and mix well.

4. Equipment:

4.1. Pyrex beaker, 2000ml.

4.2. Sieve, #200 (75 micron).

4.3. Analytical balance capable of reading to the nearest 0.1g.

4.4. Wash bottle.

4.5. A drying oven capable of maintaining a temperature of 110±5°C.

5. Procedure:

5.1. Weigh approximately 125g of aggregate onto a #200 sieve screen. Wash the sample thoroughly with tap water, then a brief final rinse with deionized water from the wash bottle. Dry to a constant mass at 110°C. Wash and dry the sieve for future use. A larger sample may be used for very coarse aggregate.

5.2. Transfer the sample to a tared 2000ml beaker and record its mass to the nearest 0.1g.

5.3. *In a fume hood,* add 1:3 HCl to the beaker until the sample is covered. If the observed reaction begins to slow, add more 1:3 HCl up to a maximum of approximately 500ml. If foam from the reaction is in danger of overflowing the container, add small amounts of water with the wash bottle until the reaction slows.

5.4. When additional 1:3 HCl does not increase the reaction rate, or the 500ml level is exceeded, slowly add small amounts of concentrated HCl until further additions do not increase the reaction rate. Be alert for excessive foaming during the initial additions.

5.5. When addition of concentrated HCl fails to increase the reaction rate, place the beaker on a hot plate and heat to approximately 80 - 90°C. Do not boil.

5.6. Decant exhausted acid and add fresh HCl until there is no further reaction, i.e. bubbling has ceased and the solution is not cloudy. Take care to avoid decanting any aggregate with the used acid.

5.7. Record the mass of the #200 sieve from step 5.1. Decant the acid and transfer the residue to the sieve.

5.8. Wash the residue thoroughly with tap water, then rinse with a small amount of deionized water.

5.9. Dry the residue to a constant mass. If a yellow or orange stain appears on the residue during the drying process, additional washing is required.

5.10. Determine the mass of the sieve and residue and subtract the previously determined sieve mass to obtain the mass of the residue.

6. **Calculations and Reporting:**

% AIR = (mass of insoluble residue/original sample mass) x 100.

Report AIR to the nearest 0.1%.

7. **References:**

- NYSDOT, Materials Method 28, Section VIII, 'Determination of Percent of Acid-Insoluble Residue'.
- ASTM D 3042-03, 'Insoluble Residue in Carbonate Aggregates'.
- VTrans Special Provisions, 'Paver Placed Surface Treatment'.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH SECTION
VT-AOT-MRD 58-12

VERMONT STANDARD PROCEDURE FOR THE DETERMINATION OF UNIXIAL COMPRESSIVE STRENGTH OF ROCK CORES

1. SCOPE

1.1. This method of test is intended for use in determining the uniaxial compressive strength of rock core samples collected from Agency projects.

2. REFERENCE DOCUMENTS

2.1. ASTM D7012 - 10 Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures.

2.2. ASTM D4543 - 08 Standard Practices for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerances.

3. APPARATUS

3.1. Apparatus shall be as described for Method D in ASTM D7012 - 10.

3.2. Concrete Saw.

3.3. Disc grinder with coarse and medium coarse disks.

3.4. Strain measuring device.

3.5. Camera.

4. SAFETY PRECAUTIONS

4.1. Protective cage around sample shall be in place during test.

4.2. Safety glasses and protective foot ware must be worn during testing.

5. PROCEDURE

5.1. Sample Collection, Selection And Preparation

5.1.1. Rock core samples are to be selected from NX sized (2.154-inch diameter) rock cores. The geologist will select representative samples for testing. Each test specimen shall be between 4.5 and 5 inches in length to ensure the final specimen after preparation maintains a length to diameter ratio of 2.0 to 2.5. The specimen shall be a solid competent specimen with no visible open fractures, voids or other potential weak features that might make preparation difficult.

5.1.2. Samples should be numbered and labeled using an indelible marker while in the rock core box. The convention is as follows: B102-R1-S3 where the first part of the number represents the boring the sample was selected from, the second number is the core run the sample was selected from and the last number is the sequential sample from that core run. In addition, the depth of the specimen should be marked on the sample. The depth corresponds to the mid-point of the specimen.

5.1.3. Each sample end is to be cut perpendicular to the axis of the specimen using the concrete saw. Care must be exercised to assure a smooth square cut end with no chipping on the ends. The ends of the samples are to be ground smooth and orthogonal with the central axis of the specimen. This is accomplished using the Eberbach disc grinder.

5.1.4. Using a caliper, measure the length and diameter of each test specimen and record on lab test data sheet (Attachment).

5.1.5. Wrap each sample in plastic wrap. Make sure excess plastic wrap does not extend over the ends of the specimen.

5.2. TESTING PROCEDURE

5.2.1. Start-Up for Tinius Olsen. Turn power on with breaker on wall. Turn pump on; run Tinius Olsen base up & down to warn up hydraulics. Turn the Jog button to off so when you are moving the base up or down you do not accidently break core or equipment.

5.2.2. Start computer & Navigator software.

5.2.3. Connect extensometer to the Tinius testing machine.

5.2.4. Install the cube testing head and platens onto the Tinius Testing machine.

5.2.5. Open the Navigator software and click on the EDIT button. Change the testing procedure in the software to the NX Core Strain test.

5.2.6. Place test specimen in the machine and place safety cage around the sample.

5.2.7. Place extensometer on the center of the specimen. Try to get it as close to the center as possible. Remove the pins from the extensometer.

5.2.8. Zero out the Load, Position and Auxiliary buttons.

5.2.9. Enter test data into the software. (Lab #, diameter, depth of sample, etc.)

5.2.10. Run the test until the sample fails.

5.2.11. Click on the Accept button to save the test results.

5.2.12. When asked to return the crosshead, click **cancel**. Manually lower the head using the down arrow in the menu bar.

5.2.13. Save the test results. The test results will be saved in C:\Rock Core.

5.2.14. Navigate to G:\Soils and Foundations\Projects\(your target project)\Rock Core Testing\ and create a subdirectory for the sample tested. The attached Figure 1 shows an example of the folder structure. Copy all test data from C:\Rock Core to the newly created sample folder on the G:\ drive. After confirming that all data was successfully copied, delete all data files in the C:\Rock Core folder. This assures that the folder is clear before the next test is performed.

5.2.15. Remove extensometer and insert pins.

5.2.16. Remove tested sample and photograph it.

5.2.17. Clean off platens of any accumulated rock fragments.

5.2.18. Repeat steps 5.2.6. to 5.2.17. for any additional samples.

5.2.19. Shut-down Tinius Olsen. When testing is finished park Tinius Olsen in the down position and shut computer down. Turn power off with breaker on wall. NOTE: Between testing (if long period of time will pass) leave Tinius Olsen powered up but turn hydraulic pump off.

5.2.20. Place tested samples back into the rock core box being careful to preserve the post-test condition and position of the core.

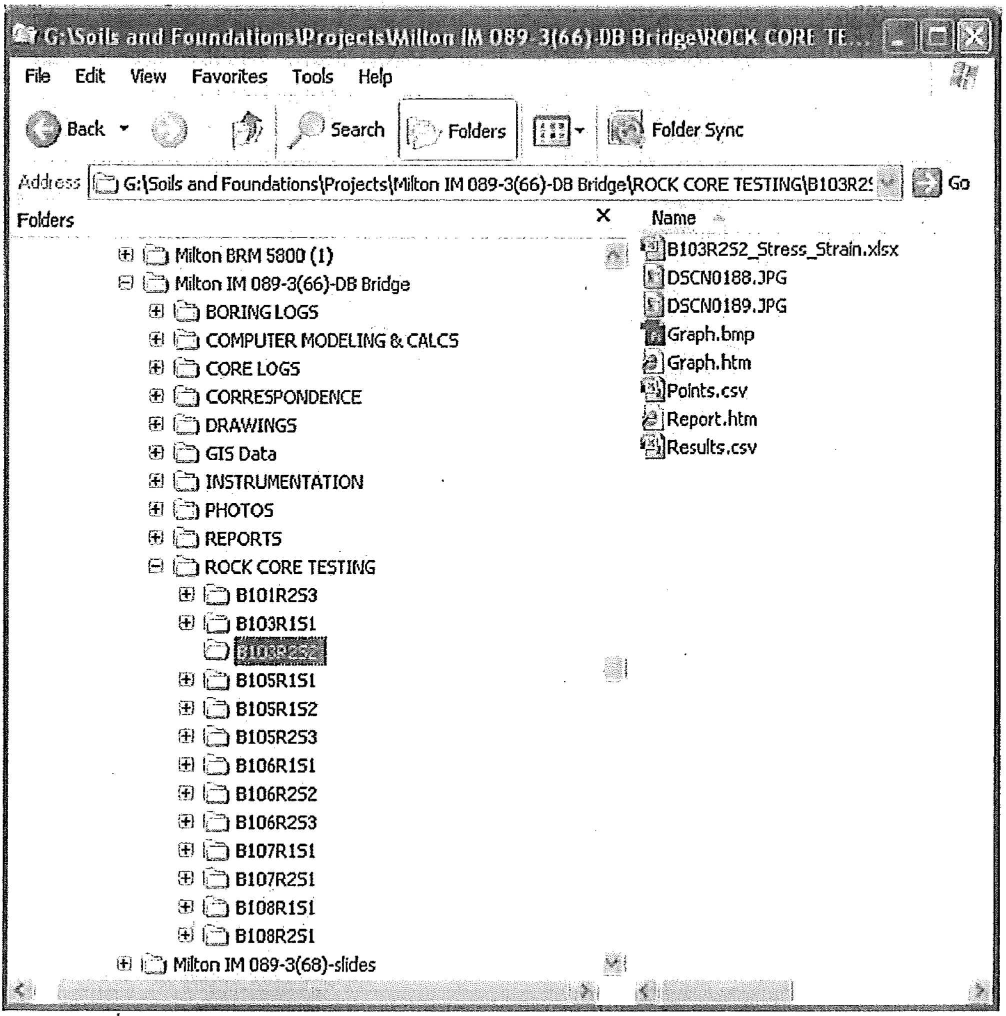
6. CALCULATIONS AND REPORTING

Upon test completion, the engineer or geologist shall prepare a graph of stress (vertical axis) vs. strain (horizontal axis) from zero-strain to sample failure.

6.1. Open the file Points.csv.

6.2. Create a new column labeled "Strain" and calculate the strain for each reading by dividing values in the *Instrument 1 (in) column* by 2.0-inches (the distance between the extensometer gauges).
6.3. For ease of use, copy the Stress column and place it to the right of the Strain column. Figure 2 in attachment shows a portion of this newly modified file.
6.4. Construct a scatter plot representing stress/strain values from zero-stress to sample failure (ideally, you want to include a point or two past failure in order to make the ultimate failure point noticeable on the graph). Save graph as a new sheet within the file you are working with.
6.5. Label the graph with the project name, project number and laboratory sample number. Label each axis and copy the information from the Graph.htm file to a text box on the graph.
6.6. Calculate Young's modulus from zero stress to ½ ultimate stress using the secant method (c) described in ASTM D7012-10 11:2.5.3. Report young's modulus and method used on the plot.
6.7. Crop the photo taken of the sample after testing and place this photo onto the plot.
6.8. Save the file in Excel according to the boring, run and sample you are working with.
Example: B104R2S3_Stess_Strain.xlsx
6.9. Have another engineer or geologist check your chart and supporting data and have them initial the checked by line in the upper right hand corner of the graph. An example of a properly prepared report is provided as Figure 3 in attachment.
6.10. The completed stress/strain file should then be saved to the folder appropriate for the particular project, boring and sample location. Please note that each sample will have its own folder (see attachment Figure 1).

ATTACHMENTS



G:\Soils and Foundations\Projects\Milton IM 089-3(66)-DB Bridge\ROCK CORE TESTING\B103R2S

- Milton BRM 5800 (1)
- Milton IM 089-3(66)-DB Bridge
  - BORING LOGS
  - COMPUTER MODELING & CALCS
  - CORE LOGS
  - CORRESPONDENCE
  - DRAWINGS
  - GIS Data
  - INSTRUMENTATION
  - PHOTOS
  - REPORTS
  - ROCK CORE TESTING
    - B101R2S3
    - B103R1S1
    - B103R2S2
    - B105R1S1
    - B105R1S2
    - B105R2S3
    - B106R1S1
    - B106R2S2
    - B106R2S3
    - B107R1S1
    - B107R2S1
    - B108R1S1
    - B108R2S1
- Milton IM 089-3(68)-slides

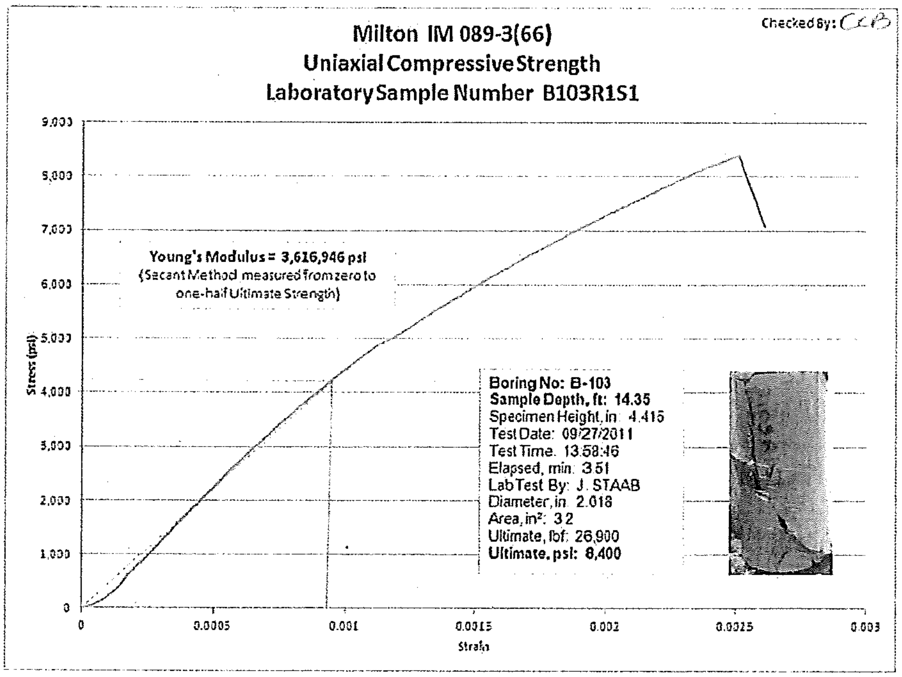
B103R2S2_Stress_Strain.xlsx
DSCN0188.JPG
DSCN0189.JPG
Graph.bmp
Graph.htm
Points.csv
Report.htm
Results.csv

Figure 1 Example of file folder structure. The Graph.bmp, Graph.htm, Points.csv, Report.htm and Results.csv files were created by the Navigator software. The jpg files are the photo files of the test sample and the B103R2S2_Stress_Strain.xlsx file is the modified Points file with chart you prepared.

ATTACHMENTS

Force (lbf)	Stress (psi)	Instrument 1 (in)	Strain	Stress (psi)
241.5	75.58	0.00028	0.00014	75.58
410.8	128.57	0.00036	0.00018	128.57
592.6	185.48	0.00043	0.000215	185.48
750.2	234.8	0.00047	0.000235	234.8
870.8	272.5	0.00051	0.000255	272.5
963	301.4	0.00053	0.000265	301.4

Figure 2 Example of modified Points.csv file with Stress/Strain columns.



Checked By: CLB

Milton IM 089-3(66)
Uniaxial Compressive Strength
Laboratory Sample Number B103R1S1

Young's Modulus = 3,616,946 psi
(Secant Method measured from zero to one-half Ultimate Strength)

Boring No: B-103
Sample Depth, ft: 14.35
Specimen Height, in: 4.415
Test Date: 09/27/2011
Test Time: 13:58:46
Elapsed, min: 3.51
Lab Test By: J. STAAB
Diameter, in: 2.018
Area, in²: 3.2
Ultimate, lbf: 26,900
Ultimate, psi: 8,400

Figure 3 Example UCS Test report.

ATTACHMENTS

Uniaxial Compressive Strength of Rock
Test Data Sheet

Equipment Used
Tinius Olsen
Epsilon Extensometer (s/n-E82765)

Specimen Prepared by: ____________
Test performed by: ____________
Date tested____________________

Project: ______________________________________ Boring: ____________

Lab number: __________

Moisture condition of core is laboratory air-dry unless recorded differently.

Temperature when tested________ Dip ______
Depth (feet)________________________
Specimen Length (in.) ________________
Specimen Diameter (in.) ______________

Geological Description
____
____
____
____

Was Extensometer removed during test? Yes_______ No_______
Was core tested to failure? Yes_______ No_______

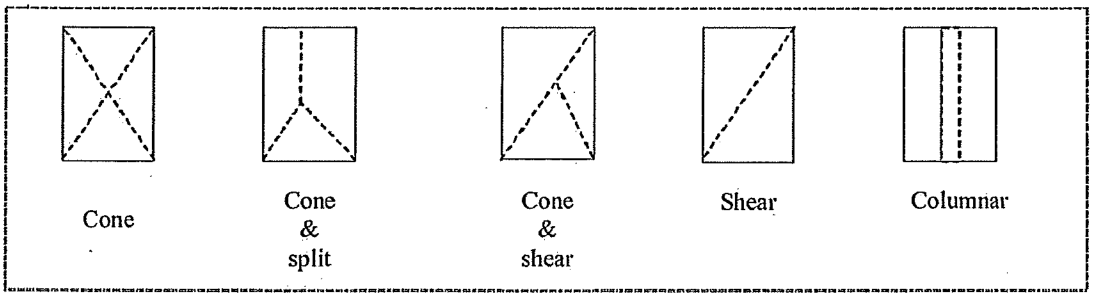
Maximum Load applied (Ultimate lbf.) ______________
Maximum Stress applied (Ultimate psi.) ______________
Young's modulus (*E*, psi.) ______________________

Comments: ____________________________________
____
____

Top

Sketched Fracture

Examples of fractures


Cone

Cone & split

Cone & shear

Shear

Columnar

VERMONT