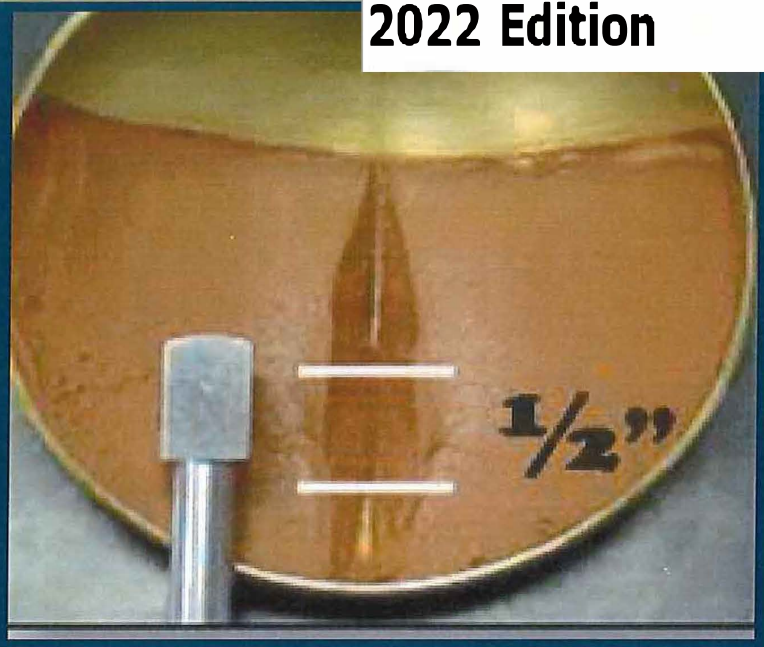
2022 Edition



PLASTICITY INDEX

Plasticity Index

2020 – Updates

- **AUDIT NOTIFICATION SLIDE ADDED TO ALL MANUALS:** To all material testers, who work on Missouri Highways, this includes Consultants, Contractors, City, County, and MoDOT workers; you will be audited by **MoDOT IAS Inspectors** and sometimes **FHWA** personnel.
- **No updates for 2020**

2021 – Updates

- **AASHTO T90: Section 6.4**
- **One small update to the procedure:**
  - **The soil shall be rolled to a thread diameter of 3 mm at least one time to be considered plastic.**

2022 – No Updates

COURSE CONTENT

Plasticity Index

MoDOT TM 79	Preparing Aggregate Base to Determine the Plasticity Index
AASHTO T 89	Determining the Liquid Limit of Soils
AASHTO T 90	Determining the Plastic Limit & Plasticity Index of Soils

Glossary

MoDOT TM 79
Preparing Aggregate to Determine the Plasticity Index

AASHTO T 90
Determining the Plastic Limit & Plasticity Index of Soils

AASHTO T 89
Determining the Liquid Limit of Soils

MoDOT TM 79
AASHTO T 89 & T 90

Aggregate Preparation
Liquid Limit
Plastic Limit
Plasticity Index

Rev 01/08/2020

SCOPE

Atterberg Limits of Soil

The Atterberg Limits is named after Albert Atterberg. He observed when water is added into a soil mass, it changes its state from solid to liquid. Albert divided the entire range from solid to liquid into four stages:

1. Solid state
2. Semi-solid state
3. Plastic state
4. Liquid state

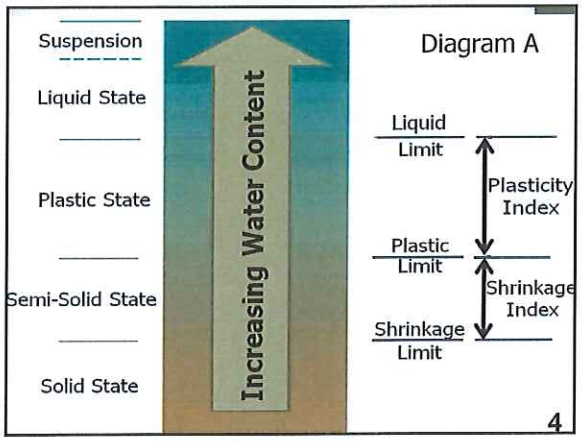
2

Albert set arbitrary limits, known as Atterberg Limits or consistency limits; for these the divisions are in terms of water content. Atterberg Limits are the water content at which the soil mass passes from one state to the next state. These limits are presented as a percentage of moisture present inside the soil. The Atterberg Limits which are commonly used for engineering purposes are:

1. Liquid limit
2. Plastic limit
3. Shrinkage limit

Scope

3



- **Shrinkage Limit**: is the point at which a material changes from a solid to a semi-solid.

NOTE: Shrinkage Limit is not covered in this certification.

Scope

5

Plastic & Liquid Limit:

- Each material becomes less stable as the moisture increases.
- A material whose percent moisture content is greater than the Liquid Limit is soft and fluid.

Scope

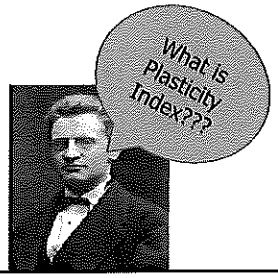
6

TERMINOLOGY

- Plastic Limit (PL) is the point at which a material moves from a semi-solid to a plastic state.
- Liquid Limit (LL) is the point at which a material moves from a plastic to a liquid state.
- Both PI and LL are used to determine Plasticity Index.

7

- Plasticity Index (PI) is a number that is derived from subtracting the Plastic Limit from the Liquid Limit.
- Plasticity Index is **not** an Atterberg limit.



Terminology

8

Preparing Aggregate to Determine the Plasticity Index

MoDOT TM - 79

9

EQUIPMENT

- #40 Sieve.
- Miscellaneous containers and pans with lids – for washing, drying, and storing.
- Mortar and pestle.
- Oven or other improvised drying unit capable of maintaining a temperature of less than 140°F (60°C).

10

SAMPLE PREPARATION - BASES

- Prepare sample in accordance with MoDOT TM 79.
- Obtain representative sample (30 to 40 lbs.).
- Reduce sample down to 500 to 2,500 g (dependent upon maximum aggregate size).
- The preparation process will produce **3 parts** which will be used to make up the final sample.

11

Sample Preparation

- **Part 1**:
- Sieve the material over the #40 (0.425 mm) sieve, set this minus #40 fraction aside. This is the **first part** of the final sample.
- Continue the next steps with the plus #40 fraction.

12

Sample Preparation

- **Part 2**:
- Place the plus #40 fraction in a pan and cover with water.
- Scrub the material to break up lumps.
- Wash over a #40 (0.425 mm) sieve and retain wash water for part 3.
- Oven dry the plus #40 fraction at ≤ 140°F (60°C); this is considered air dry.

13

Sample Preparation

- When the plus #40 fraction is dry, shake over a #40 (0.425 mm) sieve to remove any additional minus #40 material. Set this minus #40 material aside. This is the **second part** of the final sample.

14

Sample Preparation

- **Part 3**:
- Allow the wash water to settle until clear
- Siphon off the majority of clear water and oven dry at ≤ 140°F (60°C), or air-dry.
  - Note: The low oven temperature assures that any organic material in the sample remains intact.
- When dry, reduce material with mortar and pestle to pass #40 sieve. This is the **third part** of the final sample.

15

- The final sample is the combination of the three minus #40 parts.
- The three parts are:
  - **Part 1:** Minus #40 material when first sieved.
  - **Part 2:** Minus #40 material dry sieved off the scrubbed and dried plus #40 fraction.
  - **Part 3:** Minus #40 material retrieved from the wash water.
  - Mix these three parts thoroughly.

Sample Preparation

16

Sample Preparation - Soils

- Preparation of **soil** for PI is not covered in this certification.
- Refer to AASHTO Test Method AASHTO R 58 for this procedure.

17

Plastic Limit

AASHTO T90

18

SCOPE

- As the moisture content of a material moves below the Liquid Limit, it becomes more plastic.
- The minimum moisture content at which a material begins to behave as a plastic is called the Plastic Limit.

19

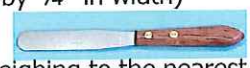
Scope

- The Plastic Limit is determined by a simple test where the material is repeatedly rolled into threads **⅛"** (3 mm) in diameter.
- The moisture content at the point where the test specimen begins to break up is the Plastic Limit.

20

EQUIPMENT

- Dish
- Spatula (3-4" long by ¾" in width)



- Scale capable of weighing to the nearest 0.01 gram

- Distilled or de-mineralized water (may use tap water if proven not to effect test results)
- Oven 230° F ± 9° (110° ± 5°C)

21

Equipment

- Flat surface for rolling (ground glass plate or piece of smooth unglazed paper)
- Containers
- Steel rod 1/8" diameter to compare your rolling thickness to.
- Optional rolling device.

22

PROCEDURE

10 g soil ball

Plastic Limit:

- Weigh an empty container with lid to the nearest 0.01 gram.
- From the thoroughly wet and mixed Liquid Limit sample, obtain about 10 grams for a test sample, anytime during mixing procedure when it can be easily shaped into a ball without sticking to your fingers.

OR

- Mix about 20 grams of material and obtain about a 10 gram test specimen.

23

Procedure

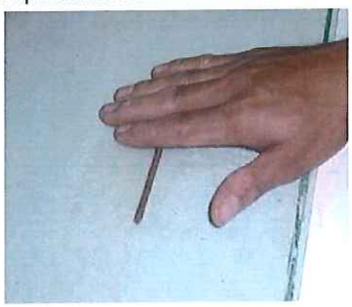
- From the 10 g ball, take 1.5 – 2 grams and squeeze it into an ellipsoidal mass.
- Protect remaining sample from further drying

Ellipsoidal soil mass

24

Plastic Limit Rolling Procedure:

- Place the 1.5 – 2 gram ellipsoidal mass on a rolling surface, applying just enough pressure to move the specimen back and forth.



Procedure

25

- Roll it back and forth with your hand at a rate of 80-90 strokes per minute until it forms a uniform diameter.
- A stoke is one complete motion of the hand forward and back to the starting position.
- Take no more than 2 minutes to roll the ellipsoidal mass into a ⅛" (3 mm)thread.

Procedure

26

- When the diameter of the thread reaches ⅛" (3 mm), squeeze the thread and form the mass back into a ellipsoidal shape.
- Repeat the rolling process until the soil can no longer be rolled into a thread and begins to crumble.

Procedure

27

Notes on Rolling:

- The thread must be rolled to ⅛" (3 mm) at least once before it crumbles.
- If the sample crumbles on the 1st roll before reaching ⅛" it's too dry, return the sample to the mixing bowl add more water, remix and roll again.
- On the 2nd roll if the thread crumbles before reaching the ⅛" (3mm) diameter, this shall be considered a satisfactory end point. Place the sample in a covered container.

Procedure

28

- Gather the portions of the crumbled soil together and place them in the moisture content container.

Plastic Limit Samples

- Immediately cover the container with a close-fitting lid to prevent additional loss of moisture.

Procedure

29

- Repeat the rolling process until the entire 10 gram specimen is tested.
- After each thread is completed, place all crumbled portions into the container and keep covered.

Plastic Limit Samples

Procedure

30

Procedure

- Weigh the container of crumbed soil to the nearest 0.01 gram and oven dry at 230 ± 9°F (110° ± 5°C).
- Test for moisture content in accordance with AASHTO T265.
- **Report:** Percent moisture to the nearest whole number.

Moisture content is the Plastic Limit.

31

Common Testing Errors:

- Improperly blended sample
- Too thin or too thick threads
- Applying too much pressure
- Non-uniform rolling
- Rolling on the wrong type surface
- Non-uniform mixing of material and water
- Contaminated water

32

Liquid Limit

AASHTO T 89

33

SCOPE

- The liquid limit of a soil is the water content, as determined in accordance with the following procedure, at which the soil passes from a plastic to a liquid state.

34

Liquid Limit Test:

- The Liquid Limit test is performed on material passing the #40 (0.425mm) sieve.
- There are two methods approved by AASHTO, we will only be reviewing **Method B**.
- Liquid Limit is a calculation based on moisture content and number of blows to closure.
- Blow count must be within 22-28 blows.

Scope

35

EQUIPMENT

- Dish
- Cover
- Spatula (3-4" long by ¾" in width)
- Liquid Limit device
- Magnifying eye piece
- Gauge block & Grooving Tool

36

Equipment

- Scale, capable of weighing to the nearest 0.01 gram
- Oven 230 ± 9°F (110 ± 5°C)
- Distilled or de-mineralized water
  - Note: May use tap water if proven not to effect test results
- Stable flat surface
- Sample containers

37

Equipment

Equipment Inspection/Calibration:

- Check the pin (connecting the cup) to verify it is not worn.
- Check that the screws connecting the cup to the hanger arm are tight.
- Check the point of contact on the cup and base for excessive wear.
  - Excessive wear is when the point of contact on the cup or base exceeds 13 mm in diameter.

38

Equipment

- Check the center of the cup to ensure that use has not worn a groove into the cup.
- Check the cam follower.
- Check the adjusting screws.
- Check the dimensions of the grooving tool.
  (May need to use an eyepiece)

- Adjust the height of the drop so that the point on the cup that contacts the base rises to a height of 10.0 ± 0.2 mm.

39

Checking Drop Height:

Equipment

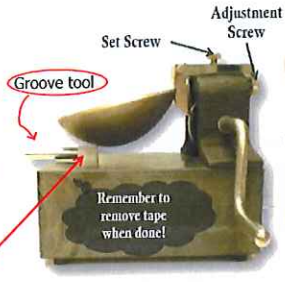
- ⋆ Calibrate Cup Drop
  - ✓ Dissect the point of contact with smooth side of tape
  - ✓ Lower cup so that it is resting on the base
  - ✓ Insert gauge block until it is in contact with the tape
    - Hold gauge block so that it lies flat against the base

40

Equipment

- ⋆ Check drop height
  - ✓ Turn crank
  - ✓ Cup should make a clicking sound without lifting from gauge block
- ⋆ To adjust drop height
  - ✓ Loosen set screw
  - ✓ Turn adjustment screw
  - ✓ Tighten set screw
- ⋆ Re-check drop height
  - ✓ Reset gauge block
  - ✓ Turn crank

10 ± 0.2 mm height



Check drop height daily before testing !

NOTE: The gauge block in the picture is on the end of a groove tool.

41

Liquid Limit Common Concerns:

- Some materials are slow to absorb water.
- When testing such materials, allow additional mixing time to ensure water absorption.
- It is possible to obtain a false value for Liquid Limit.

42

Concerns

- Some materials tend to slide on the surface of the cup instead of flowing together. If this occurs, remix the material with additional water and repeat the procedure. If the sample continues to slide at fewer than 22 blows, the Liquid Limit test is not applicable.
- Record that the Liquid Limit could not be determined.

43

PROCEDURE

- Mark the Sample ID on a clean dry sample container with lid
- Weigh the sample container
- Record the empty weight to the nearest 0.01 g
  - NOTE: This is for Moisture AASHTO T265.

44

Procedure

- Place 50 to 100 g of sample in mixing dish and add desired amount of water.
- Add 15-20 ml of distilled or demineralized water by alternately and repeatedly stirring, kneading, and chopping with a spatula.
- Further additions of water shall be made in increments of 1 to 3 ml.

Adding water too rapidly may produce a "false" liquid limit value

Add water and mix until soil obtains a peanut butter-like consistency

45

Procedure

- Mix each increment of water thoroughly into the sample before adding the next increment.
- Do not mix the sample in the Liquid Limit cup.

46

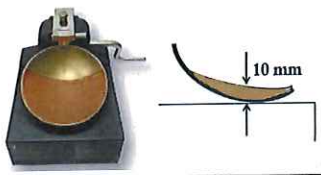
Procedure

- If too much water is added, either discard the test specimen or continue mixing and kneading the material until natural evaporation lowers the moisture content to the proper consistency.
- **DO NOT ADD ADDITIONAL DRY MATERIAL TO THE TEST SPECIMEN AFTER STARTING THE TEST!!**

47

Procedure

- Place representative specimen of mixed material into the Liquid Limit cup directly above the point where the cup rests on the base.
- Use spatula to spread and level the specimen so that the material is 10 mm deep and is centered as close as possible over the contact point of the cup.



48

- Use as few spatula strokes as possible.
- Do not trap air bubbles within the mass.
- Trim excess material from the specimen and return to mixing dish, and cover to prevent moisture loss.

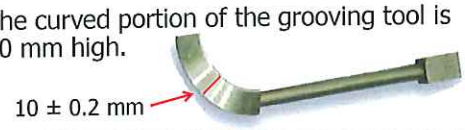
Procedure

49

Procedure

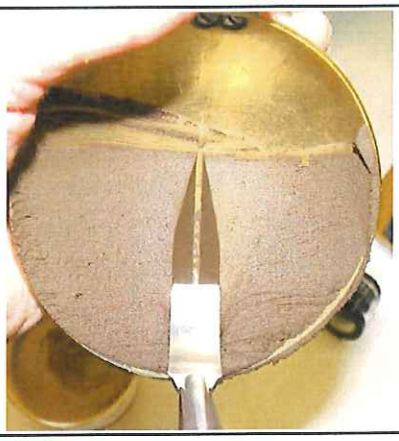
50

- Use grooving tool to make a smooth firm stroke through sample. Cut the groove along centerline of the cup.
- Do not allow the sample to tear or slide in the cup while making the groove.
- Use no more than 6 strokes to complete the division. The depth of the groove should be increased with each stroke and only the last stroke may touch the bottom of the cup.
- The curved portion of the grooving tool is 10 mm high.



Procedure

51



Procedure

52

- For a automatic device, set the counter at zero and it turn on.
- For a manual device, turn the crank at a rate of approximately 2 revolutions per second.
- **Do not hold the base of the device** with the free hand while applying blows.

Procedure

53

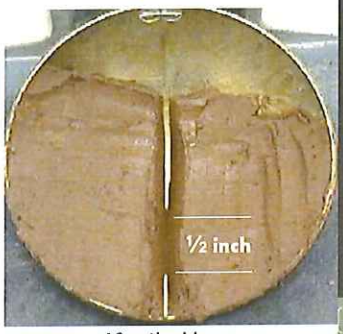
- Apply blows until the 2 sides of the material come in contact at the bottom of the groove along a distance of about a **half inch** 13 mm).
- If this is not achieved in 22 – 28 blows, remove the sample from the cup put in mixing dish, adjust sample moisture run again.
  - If blows are less than 22, continue to stir, chop and knead, which will allow moisture to evaporate.
  - If blows are more than 28, add water and mix thoroughly; allow time for water to absorb.

Procedure

54

Procedure

Before the blows.



After the blows.

55

Procedure

- After obtaining a preliminary closure in the 22 –28 blow range, immediately return remaining sample to mixing dish and, without adding any additional water, repeat procedure.
- Number of blows shall be within **± 2** of preliminary closure, however the final closure must be in the 22 – 28 blow range.
- Record the number of blows.
  - Use the blow count of the 2nd test as the result.

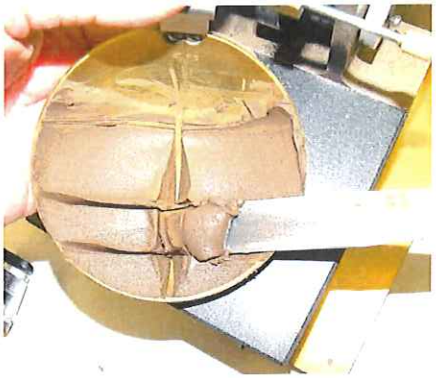
56

Procedure

- Take a slice of the sample perpendicular to the groove that includes the closure, approximately the width of the spatula **¾"** from the specimen cup.
- Remove the slice from edge to edge of the specimen at right angles to the groove.

✓ Take a sample perpendicular to the groove that includes the "closed" portion.
✓ Sample weight ≥ 10g

57

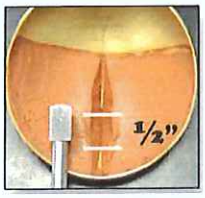


Procedure

58

Liquid Limit Procedure Summary

TESTING
- Crank 2 rev./ sec
- Count # blows
- Stop at 0.5" closure
- Do not hold device



RESULTS AT 0.5" CLOSURE
- Number of blows outside 22-28
  - Adjust moisture and retry
- Number of blows within 22 -28
  - Immediately verify the test

- **VERIFYING THE TEST**
  - Do not adjust the moisture
  - 0.5" closure is reached within ± 2 blows of the previous test
  - Record the result the verification test result

Procedure

59

- Place the slice in the container, weigh it to the nearest 0.01 gram, and record.
- Place in oven to dry at 230± 9°F (110 ± 5°C) – Constant mass
  - Perform AASHTO T265 – Moisture Content Test

Procedure

60

Procedure

- Put remaining part of the specimen back into the mixing dish and cover. This material may be used to complete the Plastic Limit test while the Liquid Limit sample is drying.
- Determine the moisture content to the nearest **0.1%** according to AASHTO T 265.

61

CALCULATIONS

Liquid Limit (LL)

$$LL = kW_N$$

LL = Liquid Limit
W_N = Water content
k = Factor given in Table 1

Report LL to nearest whole number.

62

Calculations

Liquid Limit Correction Factors "k"

Table 1

# of Blows (N)	"k" Factor
22	0.985
23	0.990
24	0.995
25	1.000
26	1.005
27	1.009
28	1.014

63

Practice Calculation

Calculations

- **Calculate the Liquid Limit;**

Trial #	1	2
Blows	22	24
Moisture		33.8

64

Calculations

Answer

$LL = kW_N$

Trial 1: no moisture calculated

Trial 2: 33.8 x 0.995 = 33.63 LL = 34

Liquid Limit = 34

65

Common Testing Errors:

- Improperly adjusted or maintained Liquid Limit device.
- Miss-counting blows.
- Holding the Liquid Limit device with hand during testing.
- Trapping air bubbles in the test specimen.
- Test specimen of improper thickness.
- Non-uniform moisture content in sample.
- Performing test before moisture content in the specimen is equalized.
- Contaminated water used for testing.
- Adding water too quickly for the material to absorb during the mixing process.

66

Plasticity Index

67

SCOPE

- The Plasticity Index (PI) of a material is a measure of the cohesive properties of a material.
- It represents the range of moisture in which a cohesive material is plastic.
- Plasticity Index is a calculated value derived by subtracting the Plastic Limit from the Liquid Limit.

68

- PI is an indicator of the suitability of the clay fraction of soil-aggregate for use in highway construction.
- Pavements constructed with soil-aggregates having a high PI tend to have problems with rutting, shifting, and shoving.

Scope

69

Scope

- When the Plasticity Index is too low or the fraction is non-plastic, material will tend to become friable (crumbles readily) in dry weather.
- It is possible for the calculations to result in a zero number, if the plastic and liquid limit are equal.
  - Such a material is reported as non-plastic, not zero.

70

CALCULATONS

- **Plasticity Index (PI)** is the Liquid Limit minus the Plastic Limit.

$$PI = LL - PL$$

- **Report to a whole number.**

71

106.3.2.79 TM-79, Procedure to Prepare Aggregate to Determine the Plasticity Index

From Engineering Policy Guide

This test method prepares Minus No. 40 materials to determine the plasticity index.

106.3.2.79.1 Apparatus

1) No. 40 (425µm) sieve

2) Miscellaneous containers and pans with lids – for washing, drying and storing.

3) Mortar and pestle.

4) Oven or other improvised drying unit capable of maintaining a temperature of less than 140° F (60° C).

106.3.2.79.2 Procedure

1) Obtain a representative sample of 30 to 40 pounds (15 to 20 kg) in the "as received" or "as obtained" condition.

2) Reduce the sample to 500 – 2500 grams, depending on the maximum size of the material.

3) Sieve the sample over a No. 40 (425µm) sieve and save both fractions. Save the minus No. 40 material as part (a).

4) Place the sieve with the plus No. 40 (425µm) portion in a pan, cover with water and scrub the material between the hands, breaking up all lumps.

5) Wash the material on the No. 40 (425µm0 sieve until the water is clear, retaining the water and material washed through.

6) The plus No. 40 (425µm) material should be dried sufficiently to allow the minus No. 40 (425µm) particles to be removed by sieving, with care being taken to avoid splattering and loss of material from the sample. Retain all minus No. 40 (425µm) material after sieving and save as part (b).

7) All of the minus No. 40 [425µm] material that was washed from the coarse portion is allowed to settle out. Most of the liquid may then be siphoned off after one or two hours, depending on the type of material being tested. It is suggested that a small quantity of vinegar (a bottle-cap full should be sufficient) be added to the water to reduce surface tension and aid settlement of particles.

8) The remaining material should be dried in an oven, sand bath, or improvised drying unit with a maximum temperature of 140 degrees F. Care should be taken to prevent splattering and loss of material from the pan. Care shall also be taken to clean the pan thoroughly so that all material will be recovered. Break the material down to pass a No. 40 (425µm) sieve using mortar and pestle. Sieve over a No. 40 (425µm0 sieve and save minus No. 40 material as part (c).

9) Combine all three parts (a), (b), and (c) of minus No. 40 (425µm) material, mix thoroughly and select a sample for test.

1001.5.2 Plasticity Index

The frequency of plastic index Quality Assurance tests shall be in accordance with the specifications. This includes retained samples from quality control tests and independent samples for quality assurance. The plasticity index is defined as the numerical difference between the liquid limit and the plastic limit. The liquid limit is the moisture content, expressed as a percentage of the weight (mass) of the oven-dried material, that the soil will flow together ½ in. (13mm) at 22-28 blows. The plastic limit is the minimum moisture content, expressed as a percentage of the weight (mass) of the oven dried material, that the soil thread can no longer be rolled into 1/8 in. (3mm) diameter thread. All original weights (masses) and calculations shall be recorded on Form T-630R (See Fig 1001.10.1 Form T-630R, page 1 and page 2.

Applying blows by turning the handle

Grooving the soil specimen

1001.5.2.1 Apparatus

(a) Apparatus for liquid limit shall conform to Section 3 of AASHTO T89. Liquid limit device may be either mechanically or manually operated. A curved grooving tool shall be used per Method B. All measurements, calibrations and adjustments shall be made in accordance with AASHTO T89 Method B. An example of material at the liquid limit is shown in Fig 1001.10.4 Liquid Limit and Plastic Limit Tests.

(b) Apparatus for plastic limit shall conform to Section 3 of AASHTO T90. A Plastic Limit Rolling Device shall not be used. Material shall be rolled using the Hand Rolling Method. An example of the crumbling of the thread is shown in Fig 1001.10.4 Liquid Limit and Plastic Limit Tests.

1001.5.2.2 Procedures

The liquid limit shall be determined in accordance with AASHTO T89 Method B, with the exception of material preparation. Material preparation shall be in accordance with MoDOT Test Method TM 79.

1001.5.2.3 Calculations

Plasticity index is calculated per AASHTO T90, as the difference between the liquid limit and plastic limit. Reported to the nearest whole number.

1001.5.2.4 Report

All original weights (masses) and calculations shall be recorded on Form T-630R. If the material is such that the plastic limit cannot be determined, the material is to be considered non-plastic. A SM sample

record for independent samples is to be filled out in accordance with Automation Section. The record shall indicate that the sample type is "Quality Assurance", Acceptance Method is "Accepted/Complete", the QA data for tests should be entered on test templates as follows: Plasticity Index on SAA008AB[1].

[1]The last letter of this template is subject to change if the template is revised. The most current template should have the designation 'NEWEST' before its description.

MoDOT TM 79: Preparing Aggregate Base Prep to Determine the Plasticity Index
Plastic Limit Tests
PROFICIENCY CHECKLIST

Applicant: _____

Employer: _____

Trial#	1	2
1. Reduced sample to required size.		
2. Sieved sample over a #40 sieve. The minus #40 is Part 1 of final sample.		
3. The plus #40 material was covered in water, scrubbed, washed over a #40 sieve and wash water retained and saved for part 3.		
4. The plus #40 material dried in 140°F oven, or air dried, then shaken over a #40 sieve. The minus #40 is Part 2 of final sample.		
5. Allowed the particles in wash water to settle, decant off water, and dried in a 140°F oven, or air dried. This is Part 3 of final sample.		
6. Combined the 3 minus #40 components to create the final sample. Part 1: Minus #40 material when first sieved. Part 2: Minus #40 material dry sieved off the scrubbed and dried plus #40. Part 3: Minus #40 material retrieved from the was waster.		
	PASS	PASS
	FAIL	FAIL

Examiner: _____ Date: _____

AASHTO T 90: Determining the Plastic Limit & Plasticity Index of Soils
PROFICIENCY CHECKLIST

Applicant: _____

Employer: _____

Trial#	1	2
1. Obtained 20 g of minus #40 material obtained by AASHTO R58 or by MoDOT TM79, or used 10 g of liquid limit material		
2. If used 20-g sample of dry material - a. Mixed with distilled or demineralized water in mixing dish b. Approximately 10 g ball obtained		
3. From the 10-g ball, form a 1.5 to 2 g ellipsoidal mass		
4. Mass rolled between fingers or palm on a glass plate or paper (or between top and bottom plate of rolling device) to form 1/8" diameter thread		
5. Rate of rolling between 80-90 strokes per minute (a stroke is one complete motion of hand forward and back to the starting position)		
6. Mass rolled for no more than 2 minutes to obtain thread diameter of 1/8"		
NOTES: * If the thread crumbled on the 1st rolling of sample, water added, remixed, and rolled again * If the thread crumbled on the 2nd rolling before reaching ⅛", rolling stopped * Failure not forced when rolling to ⅛"		
7. Pieces squeezed back together into an ellipsoidal mass		
8. Steps 4 through 7 repeated until thread crumbled, and soil can no longer be rolled into a thread		
9. Crumbled pieces placed in pre-weighed container and container immediately covered		
10. Steps 3 through 9 repeated until the 10-g specimen is completely tested (5 or more times)		
11. Mass of specimen and container determined to 0.01 g		
12. Specimen dried, and water content determined according to AASHTO T 265		
13. Plastic Limit calculated from: $PL = \frac{\text{mass of water}}{\text{mass of oven dry soil}} \times 100$		
14. Plastic Limit reported to the nearest whole number		
15. Plasticity index calculated: PI = Liquid Limit – Plastic Limit		
	PASS	PASS
	FAIL	FAIL

Examiner:_____ Date:_____

AASHTO T 89: Determining the Liquid Limit of Soils
PROFICIENCY CHECKLIST

Applicant: _____

Employer: _____

Sample Preparation Trial#	1	2
1. Sample obtained by AASHTO T 87 or MoDOT TM 79		
2. Sample consists of about 50-100-g of soil passing #40 sieve		
3. Soil mixed with about 15-20-ml of distilled or demineralized water in mixing dish (other than brass cup) **Note:** Tap water may be used if comparative tests indicate no difference in results using tap and distilled water		
4. Mixing completed by stirring, kneading and chopping with spatula		
5. Additional increments of water added (1-3 ml) until mass is uniform and correct consistency reached		
6. No additional dry material added to wet sample once test was started		
7. If too wet, sample either discarded or mixed to evaporate water		
Procedure		
1. Grooving tool checked and Liquid Limit device previously inspected for wear and height of cup drop checked		
2. Part of mixture put in cup and spread with spatula until 10 mm deep at maximum thickness		
3. As few strokes of spatula as possible used		
4. Care taken to avoid entrapment of air bubbles		
5. Excess soil returned to mixing dish		
6. Unused wet soil in storage dish covered during test		
7. (Using curved grooved tool): Material in dish divided through centerline of follower with no more than 6 strokes of curved tool and only last stroke of grooving tool scrapes bottom of cup		
8. Tearing along groove and slippage of specimen avoided		
9. Cup lifted and dropped twice per second until bottom of groove closes about 0.5" (13 mm) in 22-28 blows		
10. Material in cup immediately returned to mixing dish with no additional water added		
11. Steps 2 through 9 repeated		
12. Closure in 22 to 28 blows		
13. Number of blows recorded for second closure		
14. Moisture specimen is taken after second groove closure (if closure is in acceptable range and within ± 2 blows of the first closure)		
15. Slice of specimen, width of spatula, extending across specimen at right angles to groove, including portion that flowed together, removed from dish and placed in pre-weighed container		

AASHTO T89: Determining the Liquid Limit of Soils
PROFICIENCY CHECKLIST
(continued)

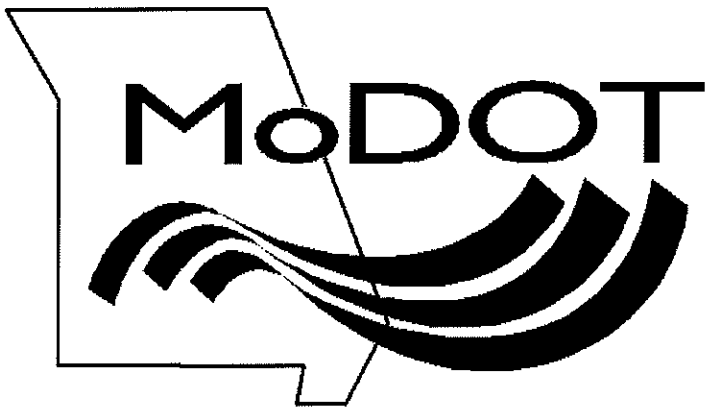
Applicant: _____

Employer: _____

16. Container and material weighed to 0.01 g		
17. Percent moisture determined according to AASHTO T265		
18. Percent moisture calculated to nearest whole percent: % moisture = $\frac{\text{mass of water}}{\text{mass of oven dry material}}$ x 100		
19. Liquid limit calculated by Liquid Limit = Correction Factor for Blows x % Moisture		
	PASS	PASS
	FAIL	FAIL

Examiner:_____Date:_____

Glossary



Glossary of Terms

Atterberg Limit: Used to identify the limits at which a soil passes from a solid, semisolid, plastic, and liquid state.

Cohesive: Tending to stick together.

Compressibility: Able to be reduced in volume through compaction.

Friable: A non-cohesive material which crumbles easily.

Liquid limit: The point at which a material moves from a plastic to a liquid state.

Plastic: Capable of being molded into a sustainable shape.

Plastic Limit: the minimum moisture content at which a material begins to behave as a plastic.

Plasticity Index: A measure of the cohesive properties of a soil. Determined by subtracting the Plastic Limit from the Liquid Limit.

Non-Plastic: Not capable of being molded into a sustainable shape.

Shrinkage Limit: The moisture content at which a soil changes from a solid to a semi-solid.