1000 STANDARD PRACTICES

1000.1 CALCULATIONS and FORMS

Throughout this manual there are test calculation procedures. These calculations are provided so that a technician has a reference to use. Many tests have, or in the future will have, computer programs written that, upon entry of test values, will perform all the calculations and generate a report. This is acceptable, so long as the computer generated values are the same as manually calculated values. It is strongly recommended that all persons performing tests are familiar with the manual procedures. Where this manual refers to specific form numbers, this is to allow a reference only and is not intended to preclude the use of computer-generated forms.

All test results either illustrated or borne out of this manual have been or will be reported using American Society for Testing and Materials (ASTM) E-29(2013).

1000.2 PRACTICE for RETAINING SIGNIFICANT DIGITS in CALCULATION and REPORTING of TEST RESULTS WHEN USING ELECTRONIC CALCULATORS or COMPUTERS

This practice is intended to provide a uniform method for calculating and reporting test results when using electronic calculators or computers. Section 1000.3 describes the methodology, Section 1000.4 lists example calculations, and Section 1000.5 lists the required number of significant digits for various test values.

Referenced Document
ASTM E 29 – Standard Practice for Using Significant digits in Test Data to Determine Conformance with Specifications.

1000.3 CALCULATION of TEST RESULTS WHERE NO INTERMEDIATE QUANTITIES are DETERMINED

In a calculation where no intermediate test values are determined, such as Bulk Specific Gravity of a bituminous mixture, perform the calculation, round and report the result to the required number of significant digits. (See Example 1 below.) When a test result from a calculation is further used in an equation to determine an additional quantity or value the result used in the subsequent equation shall be the result that has been rounded to the Mn/DOT required number of significant digits. (See Example 2.)

Example 1. Bulk Sp G = $\frac{\text{Dry Weight}}{\text{Volume}}$

Bulk Sp G = $\frac{1209.6}{495.3}$ = 2.442

Example 2. Percent Air Voids = 100 X $\frac{\text{Max. Sp G – Bulk Sp G}}{\text{Max. Sp G}}$

Percent Air Voids = 100 X $\frac{\text{Max. Sp G – } \mathbf{2.442}}{\text{Max. Sp G}}$

1000.3.1 CALCULATION of TEST RESULTS WHERE INTERMEDIATE QUANTITIES are DETERMINED

In a calculation that requires intermediate steps or determination of intermediate quantities to arrive at a test result, do not round the intermediate quantities. Intermediate steps or quantities would consist of any addition, subtraction, multiplication, and/or division required to arrive at a final result. (See Example 3.)

Example 3. Voids in Mineral Aggregate (VMA) = 100 - $\frac{\text{Bulk Sp G X Aggregate Content}}{\text{Bulk Sp G of Total Agg.}}$

$$\mathbf{VMA} = \mathbf{100} - \frac{2.442 \text{ X } 94.7}{2.703}$$

$$\mathbf{VMA} = \mathbf{100} - 85.5555\ldots = 14.4$$

1000.4 EXAMPLE CALCULATIONS for VARIOUS MATERIALS

1000.4.1 AGGREGATES

% Absorption
100[SSD weight/(SSD weight – dry weight)]
Use weights reported to the 0.1 in the equation. Resultant % Absorption is rounded to the hundredth.

Bulk specific gravity for aggregate (Gsb)

Weight dry/(SSD weight – submersed weight)
Use weights reported to the 0.1 in the equation. The resultant specific gravity is rounded to the thousandth.

Composite Bulk Specific Gravity (Gsb)

$1/[P_1/Gsb_1 + P_2/Gsb_2 + P_3/Gsb_3]$
The individual specific gravities are rounded to the thousandth, then they are inserted into the equation, and the resultant composite specific gravity is rounded to the thousandth.

Apparent Specific Gravity (Gse)

Dry Weight/(Dry Weight – submersed weight)
Use weights reported to the 0.1 in the equation. The resultant specific gravity is rounded to the thousandth.

% Absorption - Average
Round individual absorptions to the nearest hundredth, then calculate the average, and then round resultant average to the nearest hundredth.

Bulk Specific Gravity - Average
Round the individual specific gravities to the nearest thousandth, then calculate the average, and then round the resultant average to the nearest thousandth.

Apparent Specific Gravity - Average
Round the individual specific gravities to the nearest thousandth, then calculate the average, and then round the resultant average to the nearest thousandth.

1000.4.2 ASPHALT

Maximum Specific Gravity (Gmm)

Dry Weight of Sample/(Dry Weight of Sample – Submersed Weight of Sample)
Use weights reported to the 0.1 in the equation. Round resultant specific gravity to the thousandth.

Maximum Specific Gravity – Average

Round the individual specific gravities to the nearest thousandth, then calculate the average, and then round the resultant average to the nearest thousandth.

Bulk Specific Gravity (Gmb)

Dry Weight of Sample/(SSD Weight of Sample – Submersed Weight of Sample)
Use weights reported to the 0.1 in the equation. Round the result to the nearest thousandth.

Bulk Specific Gravity – Average

Round the individual specific gravities to the nearest thousandth, then calculate the average, and then round the resultant average to the nearest thousandth.

Voids

100*(1-(Bulk Specific Gravity/Maximum Specific Gravity))
The bulk and maximum specific gravities will be rounded to the thousandth and then the values are inserted into the equation. The resultant air voids is then rounded to the nearest tenth.

VMA

100-[Gmb*(100-Pb)/Gsb)]
The Gmb and the Gsb will be rounded to the thousandth, prior to their introduction into this equation. The Pb will be rounded to the tenth prior to its introduction into this equation. The resultant VMA will be rounded to the nearest tenth.

VFA

$$\mathbf{100}\frac{\mathbf{[VMA - Voids]}}{\mathbf{VMA}}$$

The resultant VFA will be rounded to the nearest tenth.

1000.4.3 TEST SUMMARY SHEET

Gradations

Gradations are entered on the test summary sheet, rounded to the whole number. The #200 sieve is an exception to this rule as it is recorded on the test summary sheet, after rounding to the nearest tenth.

Gradation – Moving Averages

Moving Average = $(P_1 + P_2 + P_3 + P_4)/4$
The individual gradation percentages are rounded to the whole number, introduced into the formula, and then the resultant average is rounded to the whole number. The #200 sieve uses the same procedure except the individuals and the averages are rounded to the nearest tenth.

Ignition Oven Calibration Factor

Calculate individual percent aggregate mass loss as follows:

$$C_{fm} = \frac{(C \mathbf{X} [1 - F]) - E}{C \mathbf{X (1-F)}}$$

The individual percent aggregate mass loss is rounded to the nearest hundredth.
The reported average calibration factor = (Cfm1 + Cfm1 + Cfm3)/3 and the resultant average is rounded to the nearest hundredth.

Asphalt Contents (Pb)

Asphalt content is calculated using the applicable Laboratory Manual method (i.e. Ignition Oven, centrifuge etc.) and rounded to the nearest tenth.

Asphalt Contents – Moving Average

Moving Average = $(Pb_1 + Pb_2 + Pb_3 + Pb_4)/4$
The individual Asphalt Contents are rounded to the tenth, introduced into the formula, and then the resultant average is rounded to the tenth.

Maximum Specific Gravities

Maximum specific gravity is calculated as above, and entered on the test summary sheet, after it has been rounded to the thousandth.

Maximum Specific Gravity – Moving Average

Moving Average = $(Gmm_1 + Gmm_2 + Gmm_3 + Gmm_4)/4$
The individual Maximum Specific Gravities are rounded to the thousandth, introduced into the formula, and then the resultant average is rounded to the thousandth.

Bulk Specific Gravity
Bulk Specific Gravity is calculated as above, and entered on the test summary sheet, after it has been rounded to the thousandth.

Air Voids

Air Voids are calculated as above, and entered on the test summary sheet, after it has been rounded to the tenth. The isolated Air Voids uses the single, corresponding maximum specific gravity and the single corresponding bulk specific gravity. The Individual Air void uses the moving average of the maximum specific gravity and the single corresponding bulk specific gravity. The moving average of the maximum specific gravity is rounded to the thousandth before it is introduced into the air void equation.

Air Voids – moving average

Moving average AV = $(AV_1 + AV_2 + AV_3 + AV_4)/4$
The individual air voids are rounded to the tenth, introduced into the formula, and then the resultant average is rounded to the tenth.

VMA

The VMA is calculated as above, and entered on the test summary sheet, after it has been rounded to the tenth.

VMA – Moving Average

Moving Average = $(VMA_1 + VMA_2 + VMA_3 + VMA_4)/4$
The individual VMA's are rounded to the tenth, introduced into the formula, and then the resultant average is rounded to the tenth.

1000.5 – Required Number of Significant Digits for Various Tests

Table 1 – AGGREGATES

TEST	REPORT TO:
Absorption	Nearest hundredth
Bulk Specific Gravity	Nearest thousandth
Composite Bulk Specific Gravity	Nearest thousandth
Apparent Specific Gravity	Nearest thousandth
% Absorption – Average	Nearest hundredth
Bulk Specific Gravity – Average	Nearest thousandth
Apparent Specific Gravity – Average	Nearest thousandth
Gradations	Whole Number except #200 sieve report to tenth.

Table 2 - ASPHALT TESTS

TEST	REPORT TO:
Maximum Specific Gravity	Nearest thousandth
Maximum Specific Gravity – Average	Nearest thousandth
Bulk Specific Gravity	Nearest thousandth
Bulk Specific Gravity – Average	Nearest thousandth
Voids	Nearest tenth
VMA	Nearest tenth
VFA	Nearest tenth

Table 3 – BITUMINOUS SUMMARY SHEET

TEST	REPORT TO:
Gradation	See Above
Gradation – Moving Averages	Whole Number except #200 sieve report to tenth.
Ignition Oven Calibration- individual result.	Hundredth %
Ignition Oven Calibration–Reported average.	Hundredth %
Asphalt Contents	Tenth %
Asphalt Contents – Moving Average	Tenth %
Maximum Specific Gravity	Nearest thousandth
Maximum Specific Gravity – Moving Average	Nearest thousandth
Bulk Specific Gravity	Nearest thousandth
Air Voids	Nearest tenth %
Air Voids – Moving Average	Nearest tenth %
VMA	Nearest tenth
VMA – Moving Average	Nearest tenth

Table 4 – Significant Digit Definitions

Tenth	0.1
Hundredth	0.01
Thousandth	0.001

1000.6 POLICY FOR HANDLING CUSTOMER COMPLAINTS REGARDING TEST RESULTS

A. Review the information contained in the report for accuracy.

B. Review the equipment calibration/verification records.

C. Review the test procedures.

D. Refer to the Engineer for resolution.

1001 RECEIVING AND IDENTIFYING SAMPLES

RECEIVING

All samples received in the laboratory will be identified as to material type, indexed in a receiving book or on a computer and assigned a laboratory sample number.

A. Sample Identification System.

1. Each type of material is assigned a two letter identification symbol (See “B” below).

2. Each sample's Laboratory Identification Number will begin with the lab identification, followed by a letter identification symbol and the last two digits of the current year, followed by the unique number. For example, the first CONCRETE AGGREGATE (CA) sample received in the Central Laboratory in the year 1999 would have a laboratory identification number CO-CA99-0001. In the districts the “CO” would be replaced with 01 for District 1, 02 for District, 03 for District 3 and so on. Lab numbers are generated by a computer system

B. Material Identification Symbols:

Code	Material Type
AC	Asphalt
AE	Asphalt Emulsion
BK	Brick
BA	Bituminous Aggregate
BC	Bituminous Cores
BM	Bituminous Mixture
CE	Cement
CI	Cement Interplant
CA	Concrete Aggregate
CX	Chemical Additive for Concrete
CL	Calcium Chloride
CB	Cut-Back Asphalt
CC	Curing Compound
CP	Pavement Cores
CM	Culvert & Misc. Cores
CY	Concrete Cylinders
DD	Drill Dust
DF	Diesel Fuel Oil
EL	Electrical
EJ	Expansion Joint

Code	Material Type
BP	Bearing Pads
EP	Epoxy Powder
FT	Fasteners
FE	Fencing (including fence posts)
FA	Fly Ash
FS	Foundation Soils
GA	Gasoline
GB	Glass Beads
GI	Gray Iron Castings
GR	Guard Rail
GS	Gravel Surfacing
JF	Joint Filler
LC	Liquid Chlorides
LT	Linear Traverse
MI	Miscellaneous
GT	Geotextiles
DT	Drain Tile
MA	Metal Analysis
MC	Miscellaneous Chemicals
TH	Thermometers
MU	Masonry Units
PO	Metal Sign Posts
PS	Prospect Sample
PA	Paint
RO	Road Oil
RS	Reinforcing Steel
SA	Rock Salt
SC	Seal Coat
SE	Seed
SF	Soil Fertility
SS	Subsoil
SL	Slag for Cement
TR	Tar
TM	Trial Mix
TT	Traffic Tape
WO	Waste Oil
WE	Weld Test Bars
WC	Water for Concrete
WM	Wire Mesh
WS	Wire Strand for Pre-stressed Concrete

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