Determination of Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21

Effective: May 1, 2007
Revised: April 12, 2017

A. Natural Aggregate RAP G_{sb}

If the RAP consists of natural aggregates only, the RAP G_{sb} shall be as follows:

District	RAP G_{sb}
1 & 2	2.660
3 - 9	2.630

B. Slag RAP Gsb RAP

If the RAP contains slag aggregate the following procedure shall be used by an independent AASHTO accredited laboratory to determine the slag RAP G_{sb}.

1. Slag RAP G_{sb} Summary of Method

A representative slag RAP sample shall be thoroughly prepared prior to testing by reheating and remixing the reclaimed material. A solvent extraction, including washed gradation for Department comparison, and two maximum theoretical specific gravity (G_{mm}) tests are performed so that an effective specific gravity (G_{se}) can be calculated. The G_{se} value is used in the calculation to determine the bulk specific gravity (G_{sb}) of the RAP.

a. Slag RAP Sampling

The slag RAP stockpile, in its final usable form, shall be sampled by obtaining a minimum of five representative samples from the slag RAP stockpile. The samples shall be thoroughly blended and split into two- 20,000 gram samples. One of the samples shall be submitted to an independent AASHTO accredited IDOT approved laboratory for the subsequent preparation and testing as specified herein. The other sample shall be submitted to the Department for optional verification testing.

b. Slag RAP Testing Equipment

Equipment including oven balances, HMA sample splitter, vacuum setup and solvent extractor shall be according to the HMA QC/QA Laboratory Equipment document in the Manual of Test Procedures for Materials. In addition the following equipment will also be required:

- Sample pans - Large, flat and capable of holding 20,000 grams of RAP material.
- Chopping utensil – Blade trowel or other utensil used to separate the large conglomerations of a RAP sample into a loose-flowing condition.

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

c. Slag RAP Sample Preparation

1) Transfer the entire 20,000 gram sample into a large flat pan(s).
2) Place sample into a preheated oven at 230 ± 9° F. (110 ± 5° C.) and heat for 30 to 45 minutes.
3) Remove the sample from the oven and begin breaking up the larger conglomerations of RAP with the chopping utensil.
4) As the material begins to soften, blend the heated RAP by mixing the freshly chopped material with the fines in the pan.
5) Return the RAP into the oven and continue heating for another 15 - 20 minutes.
6) Remove the RAP from the oven and repeat the chopping of the conglomerations and blending of the fines until the RAP sample is homogeneous and conglomerations of fine aggregate complies with Illinois Modified AASHTO T-209.
7) Place the loose RAP into a hopper or pan and uniformly pour it through a riffle splitter. Take each of the halves and re-pour through the splitter. Thoroughly blend the sample by repeating this process 2 - 3 times.

d. Slag RAP Testing

1) Percent Asphalt Binder P_b:

a) Split out a 1,500 - 2,000 gram prepared RAP sample.
b) Dry the RAP sample to a constant weight in an oven at 230 ± 9° F. (110 ± 5° C.).
c) Determine the P_b of the dried RAP sample according to Illinois Modified T 164. Record the P_b.

2) Maximum Specific Gravity determination, G_{mm}:

a) Split out one 3,000 gram prepared RAP sample.
b) Dry the sample to a constant weight in an oven at 230 ±9° F. (110 ± 5° C.) While drying, chop and break up the sample as you would with a standard G_{mm} sample. Record as “dry RAP mass”.
c) Place the sample in 295° ± 5° F. (146° ± 3° C.) oven for one hour.
d) Add 1.5 percent virgin asphalt binder (PG64-22 or PG58-22) at 295° ± 5° F. (146° ± 3° C.), based on the “dry RAP mass” from step 6.B.2, to the RAP and thoroughly mix at 295° ± 5° F. (146° ± 3° C.) to ensure uniform coating of all particles.
e) Split sample into two equal samples.
f) Determine the G_{mm} of the prepared RAP samples according to Illinois Modified AASHTO T209.

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

g) Calculate the individual G_{mm} values. The average result will be used in the calculation provided the individual results do not vary by more than 0.011. If the individual results vary more than 0.011, repeat steps in 6.B., discard the high and low values and average the remaining individual results provided they do not vary more than 0.011. If remaining individual results vary more than 0.011 repeat steps in 6.B. until individual results compare within 0.011.

e. Slag RAP Calculations:

1) Calculate the "adjusted Pb" of the RAP to account for the addition of the 1.5 percent virgin asphalt binder as follows:

a) Calculate "mass of RAP Asphalt Cement (AC)":

b) $\textit{Mass of RAP AC} = \textit{Dry RAP mass} \times \frac{P_b}{100}$

c) Calculate "mass of virgin AC added":

$$\textit{Mass of virgin AC added} = 0.015 \times \textit{Dry RAP mass}$$

d) Determine "New RAP mass":

$$\textit{New RAP mass} = \textit{Dry RAP mass} + \textit{Mass of virgin AC added}$$

e) Calculate "Adjusted P_b":

$$\textit{Adjusted } P_b = \frac{\textit{Mass of RAP AC} + \textit{Mass of virgin AC added}}{\textit{New RAP Mass}} \times 100$$

2) Calculate the effective specific gravity (G_{se}) of the RAP:

$$G_{se}\ (RAP) = \frac{(100 - \textit{Adjusted } P_b)}{\left(\frac{100}{G_{mm}} - \frac{\textit{Adjusted } P_b}{1.040}\right)}$$

3) Calculate the stone bulk gravity (G_{sb}) of the RAP:

$$G_{sb}\ (RAP) = G_{se}\ (RAP) - 0.100$$

f. Example Slag RAP G_{sb} Calculation:

- Dry RAP mass = 3,000 g

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

- P_b, (% AC) in RAP = 4.9%
- Determine "mass of RAP AC":
  - *Mass of RAP AC = Dry RAP mass x (P_b / 100)*
    = 3,000 x (4.9% / 100)
    = 147 grams

- Add 1.5 percent virgin AC:
  - Determine "mass of virgin AC added":

    Mass of virgin AC added = 0.015 x Dry RAP mass
    = 0.015 x 3,000 grams
    = 45 grams

  - Determine "New RAP mass":

    New RAP mass = Dry RAP mass + Mass of virgin AC added
    = 3,000 + 45
    = 3,045 grams

- Calculate "Adjusted P_b":

$$\text{Adjusted } P_b = \frac{Mass\ of\ RAP\ AC + Mass\ of\ virgin\ AC\ added}{New\ RAP\ Mass} \times 100$$

$$= \frac{147\ grams + 45\ grams}{3{,}045\ grams} \times 100 = 6.3\%$$

- Calculate G_{se}:

$$G_{se} = \frac{100 - P_b}{\frac{100}{G_{mm}} - \frac{P_b}{1.04}} = \frac{100 - 6.3}{\frac{100}{2.505} - \frac{6.3}{1.04}} = \frac{93.7}{39.9 - 6.1} = 2.772$$

  Adjusted P_b = 6.3%
  Rice Test, G_{mm} = 2.505

- Calculate Slag RAP G_{sb}:

$$G_{sb} = G_{se} - 0.10 = 2.772 - 0.10 = 2.672$$

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

C. RAS G_{sb}

The RAS G_{sb}, prior to adjustment using AASHTO PP78-14, is defined as 2.500. In accordance with AASHTO PP78-14 Note 6, the RAS asphalt binder availability factor is assumed equal to 0.85. The reduction in available RAS asphalt binder content equates to a reduction in G_{sb} of 0.200. This availability factor G_{sb} reduction is then applied to the RAS G_{sb} resulting in an adjusted G_{sb} of **2.300** which shall be used for all subsequent mix design and production mixture volumetric calculations.

D. G_{sb} for RAS Pre-blended with Fine Fractioned Reclaimed Asphalt Pavement (FRAP)

When RAS is mechanically pre-blended with fine FRAP, the G_{sb} for the final blended product shall be calculated as follows.

1. Calculate the weighted final blend RAS G_{sb} ($G_{sb,blended}$) using the following equations.

   a. Determine the weighting factor for the percentage of combined aggregate (P_{agg}) using: the percentage of RAS in the combined blend (P_{RAS}), the percentage of RAP in the combined blend (P_{RAP}), the asphalt binder content of the RAS before adjustment using the availability factor of 0.85 ($P_{b,RAS}$), and the asphalt binder content of the RAP ($P_{b,RAP}$).

$$P_{agg} = \frac{P_{RAS} - P_{RAS}(\frac{P_{b,RAS}}{100}) + P_{RAP} - P_{RAP}(\frac{P_{b,RAP}}{100})}{100}$$

   b. Determine the combined bulk specific gravity of the blended product ($G_{sb,combined}$) using: the RAS mix design G_{sb} equal to 2.300 ($G_{sb,RAS,design}$) and the RAP G_{sb}.

$$G_{sb,combined} = \frac{100}{\frac{P_{RAS} - P_{RAS}(\frac{P_{b,RAS}}{100})}{P_{agg}} + \frac{P_{RAP} - P_{RAP}(\frac{P_{b,RAP}}{100})}{P_{agg}}}$$
$$\frac{}{G_{sb,RAS,design}} \qquad \frac{}{G_{sb,RAP}}$$

E. Asphalt Binder Replacement Calculation (By Percent Weight of Aggregate)

The calculation of asphalt binder replacement (ABR) is completed in terms of percent weight of aggregate. It follows the percent weight of aggregate approach used in the QC/QA Package (Care-AC) available on the IDOT website.

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

1. RAS Asphalt Binder Content

RAS available asphalt binder content ($P_{b,AV}$) is calculated using the AASHTO PP78-14 availability factor of 0.85. The value of $P_{b,AV}$ is used in calculations of ABR percentage in mix design. The following examples demonstrate the use of $P_{b,AV}$ with RAS and RAP/RAS mixtures.

a. RAS Asphalt Binder Content Calculations

1) Calculate the RAS and/or RAP aggregate percentages ($RAS_{Agg\%}$ and/or $RAP_{Agg\%}$).

$$CF = \frac{100 - P_b}{100}$$

$$RAP_{Agg\%} = \frac{RAP_{mix\%}}{CF} \times \frac{100 - P_{b,RAP}}{100}$$

$$RAS_{Agg\%} = \frac{RAS_{mix\%}}{CF} \times \frac{100 - P_{b,RAS}}{100}$$

2) Calculate the RAS Available Asphalt Binder Content ($P_{b,AV}$) given the Total RAS Asphalt Binder Content.

$$P_{b,AV} = P_{b,RAS} \times 0.85$$

3) Calculate the asphalt binder contributed ($AB_{rcy\%,mix}$) from the RAP ($AB_{RAP\%}$) and/or RAS ($AB_{RAS\%}$) given the aggregate percentages of RAP and/or RAS.

$$AB_{RAP\%} = 100 \times (\frac{RAP_{Agg\%}}{100 - P_{b,RAP}}) - RAP_{Agg\%}$$

$$AB_{RAS\%} = 100 \times (\frac{RAS_{Agg\%}}{100 - P_{b,AV}}) - RAS_{Agg\%}$$

$$AB_{rcy\%,mix} = CF(AB_{RAP\%} + AB_{RAS\%})$$

4) Calculate the ABR for the mixture given the mixture total asphalt content (P_b).

$$ABR = 100 \times (\frac{AB_{rcy\%,mix}}{P_b})$$

b. Example Calculations for Increasing ABR to Compensate for the RAS Availability Factor Reduction of RAS asphalt binder content.

Example of Adjusting RAS for Additional ABR

- N70 Polymer Surface with RAS
  - P_b (%AC) in RAS = 25.0%
  - P_b (%AC) in Mixture = 6.0%
  - Maximum ABR = 10%
  - $RAS_{mix\%}$ Before Calculation of $P_{b,AV}$ = 2.4%

Step 1. Calculate the RAS and/or RAP aggregate percentages ($RAS_{Agg\%}$ and $RAP_{Agg\%}$). Note that $RAP_{\%}$ is equal to 0.0% in this example.

$$CF = \frac{100 - P_b}{100} = \frac{100 - 6.0}{100} = 0.94$$

$$RAS_{Agg\%} = \frac{RAS_{mix\%}}{CF} \times \frac{100 - P_{b,RAS}}{100} = \frac{2.4}{0.94} \times \frac{100 - 25.0}{100} = 1.9\%$$

Step 2. Calculate the RAS Available Asphalt Binder Content ($P_{b,AV}$) given the Total RAS Asphalt Binder Content.

$$P_{b,AV} = 25.0\% \times 0.85 = 21.3\%$$

Step 3. Calculate the asphalt binder contributed ($AB_{rcy\%,mix}$) from the RAS ($AB_{RAS\%}$) given the aggregate percentage of RAS.

$$AB_{RAS\%} = 100 \times (\frac{RAS_{Agg\%}}{100 - P_{b,AV}}) - RAS_{Agg\%} = 100 \times (\frac{1.9}{100 - 21.3}) - 1.9 = 0.5\%$$

$$AB_{rcy\%,mix} = CF(AB_{RAP\%} + AB_{RAS\%}) = 0.94(0.0 + 0.5) = 0.5\%$$

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

Step 4. Calculate the ABR for the mixture given the mixture total asphalt content (P_b).

$$ABR = 100 \times (\frac{AB_{rcy\%,mix}}{P_b}) = 100 \times (\frac{0.5}{6.0}) = 8.3\%$$

Step 5. If ABR is maximized, the blend percentage of RAS can be adjusted (assuming $RAS_{mix\%}$ is less than 5.0%). In this case, the RAS content will be adjusted. In order to modify the RAS content, the additional available ABR is calculated.

$$ABR_{added} = ABR_{\max} - ABR_{current} = 10 - 8.3 = 1.7\%$$

Step 6. Calculate the additional percentage of recycled asphalt binder available in the mixture.

$$AB_{rcy\%,mix,added} = \frac{(ABR_{added})(P_b)}{100} = \frac{(1.7)(6.0)}{100} = 0.1\%$$

Step 7. Calculate the additional percentage of RAS asphalt binder available in aggregate percentage.

$$AB_{RAS\%,added} = \frac{AB_{rcy\%,mix,added}}{CF} = \frac{0.1}{0.94} = 0.1\%$$

Step 8. Calculate the additional percentage of RAS aggregate.

$$RAS_{Agg\%,added} = \frac{(AB_{RAS\%,added})(100 - P_{b,AV})}{P_{b,AV}} = \frac{0.1(100 - 21.3)}{21.3} = 0.4\%$$

Step 9. Calculate the additional percentage of RAS by weight of mixture.

$$RAS_{mix\%,added} = \frac{100(CF)(RAS_{Agg\%,added})}{100 - P_{b,RAS}} = \frac{(100)(0.94)(0.4)}{100 - 25.0} = 0.5\%$$

In this case, the RAS blend percentage by weight of mixture increased from 2.4 to 2.9%. The RAS blend percentage by weight of aggregate increased from 2.0 (shown in Step 1) to 2.4% (additional 0.4% shown in Step 8).

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

Example of Adjusting RAP for Additional ABR

- N90 Surface Mixture
  - P_b (%AC) in RAS = 25.0%
  - P_b (%AC) in RAP = 5.5%
  - P_b (%AC) in Mixture = 6.0%
  - Maximum ABR = 30%
  - $RAS_{mix\%}$ Before Calculation of $P_{b,AV}$ = 5.0%
  - $RAP_{mix\%}$ Before Calculation of $P_{b,AV}$ = 10.3%

Step 1. Calculate the RAS and RAP aggregate percentages ($RAS_{Agg\%}$ and $RAP_{Agg\%}$).

$$CF = \frac{100 - P_b}{100} = \frac{100 - 6.0}{100} = 0.94$$

$$RAS_{Agg\%} = \frac{RAS_{mix\%}}{CF} \times \frac{100 - P_{b,RAS}}{100} = \frac{5.0}{0.94} \times \frac{100 - 25.0}{100} = 4.0\%$$

$$RAP_{Agg\%} = \frac{RAP_{mix\%}}{CF} \times \frac{100 - P_{b,RAP}}{100} = \frac{10.3}{0.94} \times \frac{100 - 5.5}{100} = 10.4\%$$

Step 2. Calculate the RAS Available Asphalt Binder Content ($P_{b,AV}$) given the Total RAS Asphalt Binder Content.

$$P_{b,AV} = 25.0\% \times 0.85 = 21.3\%$$

Step 3. Calculate the asphalt binder contributed ($AB_{rcy\%,mix}$) from the RAS ($AB_{RAS\%}$) and RAP ($AB_{RAP\%}$) given the aggregate percentages of RAS and RAP.

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

$$AB_{RAS\%} = 100 \times (\frac{RAS_{Agg\%}}{100 - P_{b,AV}}) - RAS_{Agg\%} = 100 \times (\frac{4.0}{100 - 21.3}) - 4.0 = 1.1\%$$

$$AB_{RAP\%} = 100 \times (\frac{RAP_{Agg\%}}{100 - P_{b,RAP}}) - RAP_{Agg\%} = 100 \times (\frac{10.4}{100 - 5.5}) - 10.4 = 0.6\%$$

$$AB_{rcy\%,mix} = CF(AB_{RAP\%} + AB_{RAS\%}) = 0.94(0.6 + 1.1) = 1.6\%$$

Step 4. Calculate the ABR for the mixture given the mixture total asphalt content (P_b).

$$ABR = 100 \times (\frac{AB_{rcy\%,mix}}{P_b}) = 100 \times (\frac{1.6}{6.0}) = 26.7\%$$

Step 5. If ABR is maximized, the blend percentages of RAS and RAP can be adjusted (assuming $RAS_{mix\%}$ is less than 5.0%). In this case, the RAP content will be adjusted because the $RAS_{mix\%}$ is equal to 5.0%. In order to adjust the RAP content, the additional available ABR is calculated.

$$ABR_{added} = ABR_{\max} - ABR_{current} = 30 - 26.7 = 3.3\%$$

Step 6. Calculate the additional percentage of recycled asphalt binder available in the mixture.

$$AB_{rcy\%,mix,added} = \frac{(ABR_{added})(P_b)}{100} = \frac{(3.3)(6.0)}{100} = 0.2\%$$

Step 7. Calculate the additional percentage of RAP asphalt binder available in aggregate percentage.

$$AB_{RAP\%,added} = \frac{AB_{rcy\%,mix,added}}{CF} = \frac{0.2}{0.94} = 0.2\%$$

Step 8. Calculate the additional percentage of RAP aggregate.

$$RAP_{Agg\%,added} = \frac{(AB_{RAP\%,added})(100 - P_{b,RAP})}{P_{b,RAP}} = \frac{0.2(100 - 5.5)}{5.5} = 3.4\%$$

Step 9. Calculate the additional percentage of RAP by weight of mixture.

$$RAP_{mix\%,added} = \frac{100(CF)(RAP_{Agg\%,added})}{100 - P_{b,RAP}} = \frac{(100)(0.94)(3.4)}{100 - 5.5} = 3.4\%$$

In this case, the RAP blend percentage by weight of mixture increased from 10.3 to 13.7%. The RAP blend percentage by weight of aggregate increased from 10.4 (shown in Step 1) to 13.8% (additional 3.4% shown in Step 8).

Example of Adjusting RAP and RAS for Additional ABR

- N90 Surface Mixture
  - P_b (%AC) in RAS = 25.0%
  - P_b (%AC) in RAP = 5.5%
  - P_b (%AC) in Mixture = 6.0%
  - Maximum ABR = 30%
  - $RAS_{mix\%}$ Before Calculation of $P_{b,AV}$ = 4.0%
  - $RAP_{mix\%}$ Before Calculation of $P_{b,AV}$ = 14.5%

Step 1. Calculate the RAS and/or RAP aggregate percentages ($RAS_{Agg\%}$ and $RAP_{Agg\%}$).

$$CF = \frac{100 - P_b}{100} = \frac{100 - 6.0}{100} = 0.94$$

$$RAS_{Agg\%} = \frac{RAS_{mix\%}}{CF} \times \frac{100 - P_{b,RAS}}{100} = \frac{4.0}{0.94} \times \frac{100 - 25.0}{100} = 3.2\%$$

$$RAP_{Agg\%} = \frac{RAP_{mix\%}}{CF} \times \frac{100 - P_{b,RAP}}{100} = \frac{14.5}{0.94} \times \frac{100 - 5.5}{100} = 14.6\%$$

Step 2. Calculate the RAS Available Asphalt Binder Content ($P_{b,AV}$) given the Total RAS Asphalt Binder Content.

$$P_{b,AV} = 25.0\% \times 0.85 = 21.3\%$$

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

Step 3. Calculate the asphalt binder contributed ($AB_{rcy\%,mix}$) from the RAS ($AB_{RAS\%}$) and RAP ($AB_{RAP\%}$) given the aggregate percentages of RAS and RAP.

$$AB_{RAS\%} = 100 \times (\frac{RAS_{Agg\%}}{100 - P_{b,AV}}) - RAS_{Agg\%} = 100 \times (\frac{3.2}{100 - 21.3}) - 3.2 = 0.9\%$$

$$AB_{RAP\%} = 100 \times (\frac{RAP_{Agg\%}}{100 - P_{b,RAP}}) - RAP_{Agg\%} = 100 \times (\frac{14.6}{100 - 5.5}) - 14.6 = 0.8\%$$

$$AB_{rcy\%,mix} = CF(AB_{RAP\%} + AB_{RAS\%}) = 0.94(0.8 + 0.9) = 1.6\%$$

Step 4. Calculate the ABR for the mixture given the mixture total asphalt content (P_b).

$$ABR = 100 \times (\frac{AB_{rcy\%,mix}}{P_b}) = 100 \times (\frac{1.6}{6.0}) = 26.7\%$$

Step 5. If ABR is maximized, the blend percentage of RAS can be adjusted (assuming $RAS_{mix\%}$ is less than 5.0%). In this example, the RAP content will be adjusted by 1.0% by weight of mixture to 15.5%. Then, this increase leads to an ABR of 28.3%. In order to adjust the RAS content, the additional available ABR is calculated.

$$ABR_{added} = ABR_{\max} - ABR_{current} = 30 - 28.3 = 1.7\%$$

Step 6. Calculate the additional percentage of recycled asphalt binder available in the mixture.

$$AB_{rcy\%,mix,added} = \frac{(ABR_{added})(P_b)}{100} = \frac{(1.7)(6.0)}{100} = 0.1\%$$

Step 7. Calculate the additional percentage of RAS asphalt binder available in aggregate percentage.

$$AB_{RAS\%,added} = \frac{AB_{rcy\%,mix,added}}{CF} = \frac{0.1}{0.94} = 0.1\%$$

Determination of
Aggregate Bulk (Dry) Specific Gravity (Gsb) of Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)
Appendix B.21
(continued)

Effective: May 1, 2007
Revised: April 12, 2017

Step 8. Calculate the additional percentage of RAS aggregate.

$$RAS_{Agg\%,added} = \frac{(AB_{RAS\%,added})(100 - P_{b,AV})}{P_{b,AV}} = \frac{0.1(100 - 21.3)}{21.3} = 0.4\%$$

Step 9. Calculate the additional percentage of RAS by weight of mixture.

$$RAS_{mix\%,added} = \frac{100(CF)(RAS_{Agg\%,added})}{100 - P_{b,RAS}} = \frac{(100)(0.94)(0.4)}{100 - 25.0} = 0.5\%$$

In this case, the RAP blend percentage by weight of mixture increased from 14.5 to 15.5%. The RAP blend percentage by weight of aggregate increased from 14.6 (shown in Step 1) to 15.6% (additional 1.0% shown in Step 8). The RAS blend percentage by weight of mixture increased from 4.0 to 4.5%. The RAS blend percentage by weight of aggregate increased from 3.3 (shown in Step 1) to 3.7% (additional 0.4% shown in Step 8).