South Dakota Asphalt Concrete Gyratory Mix Design Procedure

1. Scope:

This standard practice for mix design evaluation uses aggregate and mixture properties to produce an asphalt concrete mix design formula that meets the specification requirements. This standard is for asphalt concrete hot mix that may or may not contain reclaimed asphalt pavement (RAP).

2. Apparatus:

2.1 Gyratory compactor and support equipment (Including height recording device, specimen molds, ram heads, and mold bottoms) meeting requirements of AASHTO T 312.

2.2 All related equipment and/or apparatus to perform parts or all of tests including: SD 108, SD 201, SD 202, SD 204 SD 206, SD 208, SD 209, SD 210, SD 211, SD 212, SD 213, SD 214, SD 217, SD 220, SD 221, SD 301, SD 306, SD 309, SD 312, SD 313, SD 316, SD 318, SD 319, AASHTO T 164, AASHTO T 308, & AASHTO T 312.

3. Procedure:

3.1 Preparation of aggregates.

The average gradation of each individual aggregate fraction will be used when combining to form an aggregate composite. This average will come from testing done on the individual fraction/stockpile prior to the asphalt concrete mix design being performed.

NOTE: When recycled asphalt pavement (RAP) is allowed, it will not be included in meeting the total aggregate requirements set forth in the plans, Special Provisions, and/or Specification book.

A. The following are the minimum number of size fractions to use when recombining the gradation of each individual stockpile. The 3/4", 1/2", 3/8", #4, #8, and all material passing the #8 are the minimum number of sizes required to be used when recombining the stockpiles.

B. Bulk specific gravity of the aggregate (G_{sb}) is determined by SD 209, and SD 210 for each fraction and combining to form a composite total G_{sb} and a - #4 Gsb. SDDOT Bituminous Office will determine both the total G_{sb} and the - #4 G_{sb} on the total composite and not on individual fractions.

NOTE: When RAP is included in the plans, determine the asphalt binder content by conducting at least two extractions or ignition oven tests (Only if a correction factor is known). Determine the RAP aggregate gradation from the extractions (AASHTO T 164) or ignition oven tests (AASHTO T 308) and show the average RAP virgin aggregate only gradation on the mix design sheet. When20 percent or less RAP is used in the mix design, use the G_{sb} from the old RAP mix design for the RAP virgin mineral aggregate G_{sb} or by conducting G_{sb} tests on the extracted or ignition oven aggregate samples using SD 209 and SD 210. If more than 20 percent RAP is used to determine the RAP aggregate G_{sb} by conducting G_{sb} tests on the extracted or ignition aggregate samples using SD 209 and SD 210.

C. Determine consensus virgin aggregate properties for the composite gradation including:

Crushed particles (SD 211), fine aggregate Angularity (SD 217), flat and elongated particles (SD 212), and sand equivalent (SD 221). Also, determine source virgin aggregate properties for lightweight particles (SD 208, SD 214), sodium sulfate soundness (SD 220) (Optional), and Los Angeles abrasion loss (SD 204) (Optional), if have previous tests from pit history.

3.2 Determination of mixing and compacting temperatures.

A. Performance graded binder (PG); mixing temperature will be 300° ± 10° F.

B. Performance graded binder (PG 58-28, PG 64-22); compaction temperature will be 270° ± 5° F, (PG 58-34, PG 64-28) compaction temperature will be 275° ± 5° F. (PG 64-34, PG 70-28) compaction temperature will be 280° ± 5° F.

3.3 Preparation of mixtures.

A. Adjust the laboratory sample gradations to meet the average stockpile gradations down to the #8 and recalculate the laboratory - #8 gradation to reflect the changes. Weigh into pans material from each fraction to form a composite. Heat aggregate composite samples in an oven overnight or for a minimum of four hours to a temperature not exceeding 50° F above the mixing temperature.

NOTE: If recycled asphalt pavement is allowed, heat the RAP in an individual oven for a period of no more than two hours at 230° ± 5° F and add soon after heating to the mixture of aggregate and binder. Also, when RAP is added, care must be taken to thoroughly mix all components.

B. Following mixing immediately put the mixture in a covered container in an oven maintained at the compaction temperature for a period of two hours. At least three sets of specimens are to be made at 0.5% oil increments. This will include (2) G_{mb} samples at N_{des} and (1) G_{mb} sample at N_{max} using SD 318. Two G_{mm} (SD 312) samples are to be made at the center oil increment. The oil content will be based on the total weight of the bituminous mixture.

NOTE: This total weight of mixture would include RAP if it is allowed in the mixture and should make a gyratory specimen to the required height of 115 ± 5 mm. An example of combining virgin aggregate, RAP, lime, and virgin binder is as follows:

If 4750 grams is the target weight; hydrated lime at 1.00% = 47.5g, virgin aggregate = 3598.6g (80%), RAP = 899.6g (20%) and 4.3% new binder = 204.3g for a total of 4750 grams. The RAP contains 6.00% binder content from the average of the two extraction tests. 54.0g of binder is coming from the RAP. 54.0g + 204.3g = 258.3g of total binder in the sample for a total asphalt content of 258.3 / 4750 x 100 = 5.44%. The old asphalt binder at 1.14% is contributing 20.9% to the total binder content with a 79.1% contribution to the total binder content from the new binder at 4.30% added.

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3.4 Compaction of specimens.

Combining elements of 3.1, 3.2, and 3.3 referenced from above, compact the specimens with a gyratory compactor at the gyration levels for N_{des}, and N_{max} and calculate the N_{ini} using SD 318. The specified gyration levels are included in the plans, plan notes, Standard Specification book and/or Special Provision for a specific project. Determine the bulk specific gravity (G_{mb}) of each of the compacted specimens in accordance with SD 313.

3.5 Determine the air voids (V_a), voids in the mineral aggregate (VMA), voids filled with asphalt (VFA), and dust to effective binder for each binder percent increment in accordance with SD 318. Also include the percent of G_{mm} at N_{ini} and N_{max} for each binder increment.

4. Report:

4.1 Contractor and consultants can use and submit mix design data and calculations on their own forms and charts as long as all pertinent mix design data is included with the material sent to the SD DOT Mix Design Lab. Aggregate stockpile gradation averages including the legal pit descriptions for the materials, and the + #4 and - #4 bulk specific gravity of each individual stockpile are data which needs to be included with the mix design submittal. The asphalt binder supplier and grade of binder to be used will be listed. A completed DOT 48 form for moisture sensitivity (SD 309) will also be included with the mix design data submitted (If not adding 1.00% hydrated lime) The

Contractor's material and data submitted to the SD DOT Mix Design Lab in Pierre must meet all of the specifications and requirements as shown in the plans, plan notes, Standard Specifications book and the Special Provision regarding quality control/quality assurance specifications that apply to the project.

4.2 The Contractor's mix design submittal will include a single percentage of binder recommended, the source of the binder, bin splits selected to use along with the legal pit descriptions of all the materials, average gradation of the stockpiles, and the recommended JMF to be used for the mix design along with a signed JMF mix design sheet including all the required mix design test results.

4.3 The SD DOT Mix Design Lab will verify the mix design submitted by the Contractor/Area and conduct all necessary mix design quality tests required on the mineral aggregate, RAP, and asphalt concrete mixture. When the mix design verification is completed by the Department's Bituminous Mix Design Lab, an approved mix design report (DOT-64) will be provided to the Area Engineer and the Contractor prior to production.

5. References

Listed in 2.2 above