

# CONSTRUCTION BULLETIN

C-14

D-6

TEXAS HIGHWAY DEPARTMENT  
CONSTRUCTION DIVISION

## FOREWORD

This Bulletin has been prepared by the Construction Division of the Texas Highway Department for the purpose of furnishing the Field Engineers, Inspectors and Contractors with the proper procedure to be followed in the design and control of Asphaltic Concrete Paving Mixtures in accordance with the governing specifications. Some specification requirements may change from time to time, however, this will not affect the design principles and procedures presented in this Bulletin. In the event of any conflict between this Bulletin and the Specifications, the Specifications shall govern.

Bulletin C-14 describes the necessary preliminary testing of the aggregates, the method of combining the aggregates in order to meet the combined grading requirements, the design, mixing and testing of the preliminary mixes, the use of test results obtained from testing the preliminary mixes, and the necessary testing of the aggregates for compliance with specification requirements and job control.



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# **HOT MIX ASPHALTIC CONCRETE PAVEMENT**

## PRELIMINARY TESTS ON MINERAL AGGREGATES

As soon as possible, the Contractor shall make the aggregates, actually proposed for use, available for sampling by the Engineer. Each representative sample should contain not less than 100 pounds of material, or should be large enough so that all testing may be done, including enough material for use in preparing the laboratory mixtures. The testing of the aggregates may be divided into two groups. The tests under Group I are made to determine whether the aggregates meet the specification requirements. It is recommended that samples of the aggregates be submitted to the District or Austin Laboratory for making the tests shown under Group I and, where laboratory equipment permits, these same preliminary tests should be made by the field laboratory inspector. The tests under Group II are made to determine certain physical characteristics of the aggregates which are required to be known in the design and control of the asphaltic concrete mixtures. It is recommended that both the field laboratory inspector and the District laboratory make the tests shown under Group II.

### GROUP I TESTS

1. Determine the abrasion of the coarse aggregate in accordance with Test Method Tex-410-A.
2. For coarse aggregate, determine the amount of organic matter, clay lumps, loam, or particles coated therewith in accordance with Test Method Tex-217-F (Part I), and determine the per cent of material removed (Decantation) in accordance with Test Method Tex-217-F (Part II).
3. When required by the specifications, determine the per cent of particles of the coarse aggregate having more than one crushed face in accordance with Test Method Tex-413-A (Particle Count).
4. Determine the plasticity index of that part of the fine aggregate passing the No. 40 sieve in accordance with Test Method Tex-106-E.
5. Determine the sand equivalent of the combined aggregates in accordance with Test Method Tex-203-F.

### GROUP II TESTS

1. Make a sieve analysis of each aggregate sample in accordance with Test Method Tex-200-F (Dry Sieve Analysis). Use sieve sizes specified in the governing specifications. Do not use "Washed Sieve Analysis" procedure.
2. Determine the bulk specific gravity of each aggregate in accordance with Test Method Tex-201-F and/or Test Method Tex-202-F.
3. Calculate the water absorption of each aggregate in accordance with Test Method Tex-201-F.

## SELECTION OF AGGREGATE GRADING

This phase of design consists of determining the amount of each aggregate to use in the asphaltic concrete mixture. All tests as outlined under "Preliminary Tests" should have been completed prior to beginning this operation with the exception of determining the sand equivalent value. After the amount of each aggregate to be used in the mixture has been determined, the sand equivalent value may be determined on the combined materials prior to processing by the plant and prior to the addition of asphalt and mineral filler, if used; but the sand equivalent value obtained can only be used for informational purposes.

It is the responsibility of the Engineer to designate the exact grading of the aggregate to be used in the mixture. Careful consideration should be given to the requirements for stability, durability, and skid resistance when selecting this grading. In selecting the proportions of each aggregate to be used in the mix, calculate the combined sieve analysis, using the proportion of each proposed aggregate considered to be desirable. Tabulate these calculations and the combined grading on Construction Form No. 544 Rev.(2), and show the grading requirements of the specifications in an adjacent column or in the right margin of this form. If the combined analysis does not meet the specifications, other proportions must be assumed or another aggregate must be secured, and then the calculations must be repeated until the combined grading is within the limits of the grading specified.

In general, when selecting a grading for trial mixes, particularly for surface courses, the controlling gradation is the material retained on the 10 mesh sieve and passing the 10 mesh sieve. The grading of the material retained on the 10 mesh sieve should be near or slightly in excess of the midpoint of the specifications after adding the asphalt cement; however, this may be changed up or down from the trial mix design to secure the workability or the surface texture desired by the Engineer after production of asphaltic concrete begins, provided that other requirements of the specifications are met. Usually, but not always, a grading in excess of the midpoint of the specifications by several percentage points will produce a relatively flat stability curve, particularly when using crushed aggregates, and will produce a mixture in which the asphalt content is not as critical as a finer graded mixture. This will allow the use of a slightly higher density in the mixture, and will produce a more durable pavement.

For example, assume that it is desired to design a Type "D" Mix under Standard Specification Item 340, and the following aggregates are available:

Aggregate A: Crushed Limestone (3/8-inch maximum size): This material consists of medium dense, gray-brown limestone. This material is produced from the Zero Pit, 5.0 miles west of Cold, and this sample was taken from a stockpile.

Aggregate B: Crushed Limestone Screenings: This material consists of screenings resulting from crushing the previously described limestone. It was taken from a stockpile adjacent to the Aggregate A stockpile.

Aggregate C: Blow Sand: This material consists of fine siliceous sand. It was taken from a State Highway borrow pit, one mile north of Cold.

1. The three samples above are dried to constant weight in order to eliminate any possible moisture variable.

2. The following table shows the complete sieve analysis of each of the aggregate samples, made in accordance with Test Method Tex-200-F (Dry Sieve Analysis).

| <u>Size</u> | <u>Aggr. A<br/>(3/8" Aggr.)</u> | <u>Aggr. B<br/>(Screenings)</u> | <u>Aggr. C<br/>(Blow Sand)</u> |
|-------------|---------------------------------|---------------------------------|--------------------------------|
| 1/2" - 3/8" | 2.3                             | 0.0                             | 0.0                            |
| 3/8" - 4    | 66.0                            | 0.0                             | 0.0                            |
| 4 - 10      | 30.5                            | 18.6                            | 0.0                            |
| 10 - 40     | 0.6                             | 45.0                            | 0.8                            |
| 40 - 80     | 0.4                             | 16.8                            | 56.2                           |
| 80 - 200    | 0.2                             | 8.9                             | 40.7                           |
| Pass 200    | <u>0.0</u>                      | <u>10.7</u>                     | <u>2.3</u>                     |
| Total       | 100.0                           | 100.0                           | 100.0                          |

3. The bulk specific gravities of the above samples, determined in accordance with Test Method Tex-201-F and Test Method Tex-202-F, were found to be as follows:

| <u>Sample</u>                      | <u>Bulk Sp.Gr.</u> |
|------------------------------------|--------------------|
| Aggregate A (Limestone, 3/8" Max.) | 2.584              |
| Aggregate B (Limestone Screenings) | 2.554              |
| Aggregate C (Blow Sand)            | 2.627              |

In examining the specifications, note that the total retained on the 10 mesh sieve requires from 50-70%. The midpoint of this requirement is 60%. An examination of the three aggregates available shows that most of the plus 10 mesh material must come from Aggregate A, so we will arbitrarily choose 60% of this material for our first trial. When available, it is always desirable to add a silica sand containing 40-80 and 80-200 mesh sizes. These sizes in a sand are commonly called the carrier sizes and tend to lubricate the mixture, producing a more workable mix. With this point in mind, let us assume 10% of Aggregate C. The remaining amount of aggregate will be made up of the screenings and will be  $100\% - (60\% + 10\%) = 30\%$ . In other words, our first trial combination will require 60% Aggregate A, 30% Aggregate B, and 10% Aggregate C, making a total of 100%.

Aggregate A will contribute 60.0 per cent of each of its various sizes to the combination; for example:

|             |   |              |   |            |
|-------------|---|--------------|---|------------|
| 1/2" - 3/8" | = | 2.3% x 60.0% | = | 1.4%       |
| 3/8" - 4    | = | 66.0 x 60.0  | = | 39.6       |
| 4 - 10      | = | 30.5 x 60.0  | = | 18.3       |
| 10 - 40     | = | 0.6 x 60.0   | = | 0.4        |
| 40 - 80     | = | 0.4 x 60.0   | = | 0.2        |
| 80 - 200    | = | 0.2 x 60.0   | = | <u>0.1</u> |
|             |   | Total        |   | 60.0%      |

Likewise, Aggregate B will contribute 30.0 per cent of each of its various sizes to the combination; for example:

|          |   |       |   |       |   |            |
|----------|---|-------|---|-------|---|------------|
| 4 - 10   | = | 18.6% | x | 30.0% | = | 5.6%       |
| 10 - 40  | = | 45.0  | x | 30.0  | = | 13.5       |
| 40 - 80  | = | 16.8  | x | 30.0  | = | 5.0        |
| 80 - 200 | = | 8.9   | x | 30.0  | = | 2.7        |
| Pass 200 | = | 10.7  | x | 30.0  | = | <u>3.2</u> |
|          |   | Total |   |       |   | 30.0%      |



And Aggregate C will contribute 10.0 per cent of each of its various sizes to the combination; for example:

|          |   |      |   |       |   |            |
|----------|---|------|---|-------|---|------------|
| 10 - 40  | = | 0.8% | x | 10.0% | = | 0.1%       |
| 40 - 80  | = | 56.2 | x | 10.0  | = | 5.6        |
| 80 - 200 | = | 40.7 | x | 10.0  | = | 4.1        |
| Pass 200 | = | 2.3  | x | 10.0  | = | <u>0.2</u> |
|          |   |      |   | Total |   | 10.0%      |

Combining these various sizes of the three aggregates, we have the theoretical sieve analysis of the combination, as follows:

| <u>Size</u> | Aggr. A<br><u>3/8" Aggr.</u> | + | Aggr. B<br><u>Screenings</u> | + | Aggr. C<br><u>Blow Sand</u> | = | <u>Combinations</u> |
|-------------|------------------------------|---|------------------------------|---|-----------------------------|---|---------------------|
| 1/2" - 3/8" | 1.4                          | + | 0.0                          | + | 0.0                         | = | 1.4                 |
| 3/8" - 4    | 39.6                         | + | 0.0                          | + | 0.0                         | = | 39.6                |
| 4 - 10      | 18.3                         | + | 5.6                          | + | 0.0                         | = | <u>23.9</u> 64.9    |
| 10 - 40     | 0.4                          | + | 13.5                         | + | 0.1                         | = | 14.0                |
| 40 - 80     | 0.2                          | + | 5.0                          | + | 5.6                         | = | 10.8                |
| 80 - 200    | 0.1                          | + | 2.7                          | + | 4.1                         | = | 6.9                 |
| Pass 200    | <u>0.0</u>                   | + | <u>3.2</u>                   | + | <u>0.2</u>                  | = | <u>3.4</u>          |
|             | 60.0                         |   | 30.0                         |   | 10.0                        |   | 100.0               |

Construction Form No. 544 Rev.(2) on Page 6 is made for the convenience of the inspector and shows the aggregate combination in tabular form. This form should be used in calculating trial combinations.

Tabulating this combination grading alongside the grading requirements of the specifications, we have:

| <u>Size</u> | Combination<br><u>Grading</u> | Specification<br>Requirements<br><u>Item 340, Type D</u> |
|-------------|-------------------------------|--|
| 1/2" - 3/8" | 1.4                           | 0 - 5  |
| 3/8" - 4    | 39.6                          | 20 - 50  |
| 4 - 10      | <u>23.9</u> 64.9              | 10 - <u>30</u> 50 - 70                                   |
| 10 - 40     | 14.0                          | 0 - 30   |
| 40 - 80     | 10.8                          | 4 - 25   |
| 80 - 200    | 6.9                           | 3 - 25   |
| Pass 200    | <u>3.4</u>                    | 0 - 8  |
|             | 100.0%                        |  |

Average Bulk Specific Gravity of Aggregate  
Combination (Test Methods Tex-201-F and Tex-202-F) = 2.579

A study of the above tabulation shows that the combined analysis meets the specifications.

In order not to make the above example unnecessarily long or involved, it was adjusted so that the first trial would be acceptable, but in actual practice, the designer is seldom so fortunate.

### DESIGN OF LABORATORY MIXES

The most fundamental and important factor in asphaltic concrete mix design is the proportion of the aggregate and the asphalt. The proportion of the aggregate and the asphalt affects the stability, the skid resistance, and the durability of the pavement. If the pavement has excess density, it will become

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Texas Highway Department  
Construction Form No. 544 Rev. (2)

**TEXAS HIGHWAY DEPARTMENT  
ASPHALTIC CONCRETE SIEVE ANALYSIS WORK SHEET**

County Monroe Highway S. H. 2000 Project F 1(234) Control 5-6-7  
Date 9-4-67 Time \_\_\_\_\_ Station \_\_\_\_\_ Sampled By \_\_\_\_\_  
Spec. Item 340 Type D Design No. Selection of Grading

| Sieve Size    | Aggregate A<br>Bin No. 1 (a) |           |        | Aggregate B<br>Bin No. 2 (b) |           |        | Aggregate C<br>Bin No. 3 (c) |           |        | Bin No. 4 (d)  |           |   | Combined Analysis %<br>(a+b+c+d) | Spec. |
|---------------|------------------------------|-----------|--------|------------------------------|-----------|--------|------------------------------|-----------|--------|----------------|-----------|---|----------------------------------|-------|
|               | Weight (grams)               | Total % x | 60.0 % | Weight (grams)               | Total % x | 30.0 % | Weight (grams)               | Total % x | 10.0 % | Weight (grams) | Total % x | % |                                  |       |
| 1 1/4" - 3/4" |                              |           |        |                              |           |        |                              |           |        |                |           |   |                                  |       |
| 3/4" - 3/8"   |                              |           |        |                              |           |        |                              |           |        |                |           |   |                                  |       |
| 3/8" - 3/16"  |                              |           |        |                              |           |        |                              |           |        |                |           |   |                                  |       |
| 1/2" - 3/16"  | 33                           | 2.3       | 1.4    | 0                            | 0.0       | 0.0    | 0                            | 0.0       | 0.0    |                |           |   | 1.4                              | 0-5   |
| 3/8" - 4"     | 952                          | 66.0      | 39.6   | 0                            | 0.0       | 0.0    | 0                            | 0.0       | 0.0    |                |           |   | 39.6                             | 20-50 |
| 1/4" - 10"    |                              |           |        |                              |           |        |                              |           |        |                |           |   |                                  |       |
| 4 - 10        | 440                          | 30.5      | 18.3   | 151                          | 18.6      | 5.6    | 0                            | 0.0       | 0.0    |                |           |   | 23.9                             | 10-30 |
| + 10          |                              |           | 59.3   |                              |           | 5.6    |                              |           | 0.0    |                |           |   | 64.9                             | 50-70 |
| 10 - 40       | 9                            | 0.6       | 0.4    | 365                          | 45.0      | 13.5   | 3                            | 0.8       | 0.1    |                |           |   | 14.0                             | 0-30  |
| 40 - 80       | 6                            | 0.4       | 0.2    | 136                          | 16.8      | 5.0    | 225                          | 56.2      | 5.6    |                |           |   | 10.8                             | 4-25  |
| 80 - 200      | 3                            | 0.2       | 0.1    | 72                           | 8.9       | 2.7    | 163                          | 40.7      | 4.1    |                |           |   | 6.9                              | 3-25  |
| Pass 200      | 0                            | 0.0       | 0.0    | 87                           | 10.7      | 3.2    | 9                            | 2.3       | 0.2    |                |           |   | 3.4                              | 0-8   |
| Total         | 1443 gm                      | 100.0%    | 60.0%  | 811 gm                       | 100.0%    | 30.0%  | 400 gm                       | 100.0%    | 10.0%  |                |           |   | % 100.0%                         |       |

| Bin No. | (a) Tare Wt. (gms.) | (b) Gross Wet Wt. (gms.) | (c) Gross Dry Wt. (gms.) | (d) Wt. Moist. (gms.)<br>b-c | (e) Dry Wt. Aggr. (gms.)<br>c-a | % Moist.<br>$\frac{d}{e} \times 100\%$ |
|---------|---------------------|--------------------------|--------------------------|------------------------------|---------------------------------|--|
| 1       |                     |                          |                          |                              |                                 |  |
| 2       |                     |                          |                          |                              |                                 |  |
| 3       |                     |                          |                          |                              |                                 |  |
| 4       |                     |                          |                          |                              |                                 |  |

Asphaltic Binder = \_\_\_\_\_ %  
Total = 100.0%

*John Doe*  
Inspector

asphalt, the mixture being too coarse, or the mixture being too cold, it will lack durability and will ravel. Inspectors are hereby cautioned that, while density problems can be caused by the mix, there are other reasons for low density. Inadequate compactive effort, not completing the rolling while the mix is still hot enough to be compacted to proper density, improper or an excessive amount of hand-raking behind the paver, improper paver operation, or using a paver that is not in good operating condition can also cause low density in the pavement. It is recommended that, if improper density is detected, both the plant and the road operations be thoroughly studied and immediate remedial action be taken.

The design asphalt content should be selected to produce a pavement which has good stability, durability, and skid resistance without sacrificing any one of the characteristics for the other; however, today's modern, high-speed traffic makes skid resistance a prime consideration in the design of asphaltic concrete pavements. Certain weather and traffic conditions may make it desirable to design slightly below the optimum density in order to maintain skid resistance, even at the risk of a slight loss in durability. It is obvious that the design asphalt content is a highly critical point and that a factor of such vital importance must be thoroughly understood and intelligently controlled.

In determining the optimum asphalt content it is necessary to design and mold asphaltic concrete test mixtures containing five different asphalt contents. Three specimens of each asphalt content should be mixed, molded and tested for density and stability. The average of these values for each of the five different mixtures is used in determining the optimum asphalt content. These mixes are small and must be controlled very accurately in order to insure against undesirable variables which would invalidate test results.

To insure adequate grading control for all test mixes, the mineral aggregates containing an appreciable amount of material retained on the 10 mesh sieve should be cut into the following sizes and their percentages determined:

- Retained on 7/8"
- 7/8" - 3/8"
- 3/8" - 4
- 4 - 10 mesh
- Passing 10 mesh

Aggregates whose sizes are predominantly smaller than 10 mesh may be proportioned as they are, since a minimum of segregation occurs in the smaller sizes; for example:

The greater part of Aggregate A (crushed limestone, 3/8-inch maximum size) is retained on the 10 mesh sieve; therefore, it is cut into the following sizes:

| <u>Size</u>       | <u>Per Cent by Weight</u> |
|-------------------|---------------------------|
| Retained 4 Mesh   | 68.3                      |
| 4 Mesh to 10 Mesh | 30.5                      |
| Passing 10 Mesh   | <u>1.2</u>                |
| Total             | 100.0                     |

Aggregate B will be separated into two sizes; from No. 4 Mesh to No. 10 Mesh and minus No. 10 Mesh and handled similarly to Aggregate A.

To design laboratory mixes containing the grading selected, it is necessary to use 60.0 per cent of Aggregate A, which has been cut into three sizes to eliminate segregation, 30% of Aggregate B, which has been cut into two sizes, and 10% of Aggregate C. Tabulating these percentages, we obtain:

| <u>Aggregate</u> |           | <u>Per Cent by Weight</u><br><u>(Individual)</u> | <u>Per Cent by Weight</u><br><u>(Cumulative)</u> |
|------------------|-----------|--|--|
| Aggregate A      | Ret.No. 4 | 41.0   | 41.0   |
| (Crushed Stone)  | 4 - 10    | 18.3   | 59.3   |
|                  | Pass 10   | 0.7  | 60.0   |
| Aggregate B      | 4 - 10    | 5.6  | 65.6   |
| (Screenings)     | Pass 10   | 24.4   | 90.0   |
| Aggregate C      |           |  |  |
| (Blow Sand)      | (Total)   | <u>10.0</u>                                      | 100.0  |
|                  | Total     | 100.0  |  |

The asphalt contents for the five laboratory mixes shall be the maximum, minimum, midpoint and quarter points covered by the governing specifications. For example, assume a Type "D" Mix under Item 340, which requires from 4.0 to 8.0 per cent by weight of asphalt. Therefore, the asphalt contents for the five laboratory mixes will be 4.0, 5.0, 6.0, 7.0 and 8.0 per cent by weight.

The standard specifications for hot-mix asphaltic concrete set exact limits for each size of aggregate and the asphalt which comprise the total mixture. In other words, the laboratory mix employing 4.0 per cent asphalt will contain 96.0 per cent aggregate of the grading previously selected, and the 5.0 per cent asphalt mixture will contain 5.0 per cent asphalt and 95.0 per cent aggregate of the same grading and so on down the line through 8.0 per cent.

In order to select the optimum asphalt content for the grading selected, we must design the following mixes:

| <u>Mix No.</u> | <u>Asphalt</u><br><u>(Per Cent by Weight)</u> | <u>Aggregate</u><br><u>(Per Cent by Weight)</u> |
|----------------|---|---|
| 1              | 4.0   | 96.0  |
| 2              | 5.0   | 95.0  |
| 3              | 6.0   | 94.0  |
| 4              | 7.0   | 93.0  |
| 5              | 8.0   | 92.0  |

The design of all the above mixes will be identical so we will choose Mix No. 1 as an example.

We have selected the combined grading on Page 6, and on this page we calculated the percentages of the three cuts of Aggregate A, the percentages of the two cuts of Aggregate B, and the percentage of Aggregate C required to produce

(See Page 8) by 0.96 and add the 4.0% asphaltic binder, we will have the proper proportions of all ingredients for Mix No. 1; for example:

| <u>Aggregate</u> | Individual<br>% by Wt. of<br>Total Aggr.<br>(See Page 8) |                | Individual<br>% by Wt. of<br><u>Total Mix</u> | Cumulative<br>% by Wt. of<br><u>Total Mix</u> |
|------------------|--|----------------|---|---|
| A - Ret. on 4    | 41.0   | x 0.96 =       | 39.3  | 39.3  |
| A - 4 - 10       | 18.3   | x 0.96 =       | 17.6  | 56.9  |
| A - Pass 10      | <u>0.7</u>   | x 0.96 =       | <u>0.7</u>                                    | 57.6  |
|                  | 60.0   |                | 57.6  |   |
| <br>             |  |                |   |   |
| B - Ret. on 10   | 5.6  | x 0.96 =       | 5.4   | 63.0  |
| B - Pass 10      | 24.4   | x 0.96 =       | 23.4  | 86.4  |
| <br>             |  |                |   |   |
| C - (Total)      | <u>10.0</u>  | x 0.96 =       | <u>9.6</u>                                    | 96.0  |
|                  | 100.0  |                | 96.0  |   |
|                  |  | Asphalt Binder | <u>4.0</u>                                    | 100.0   |
|                  |  |                | 100.0   |   |

These proportions when multiplied by the total weight of Mix No. 1 will give the required amount of each cut and size necessary to produce a 1000-gram mix, for example:

| <u>Aggregate</u> |       |                 | Individual<br><u>Weights</u> | Cumulative<br><u>Weights</u> |
|------------------|-------|-----------------|------------------------------|------------------------------|
| A - Ret. on 4    | 39.3% | x 1000. grams = | 393.0                        | 393.0                        |
| A - 4 - 10       | 17.6  | x 1000. grams = | 176.0                        | 569.0                        |
| A - Pass 10      | 0.7   | x 1000. grams = | 7.0                          | 576.0                        |
| <br>             |       |                 |                              |                              |
| B - 4 - 10       | 5.4   | x 1000. grams = | 54.0                         | 630.0                        |
| B - Pass 10      | 23.4  | x 1000. grams = | 234.0                        | 864.0                        |
| <br>             |       |                 |                              |                              |
| C - (Total)      | 9.6   | x 1000. grams = | 96.0                         | 960.0                        |
| Asphalt          | 4.0   | x 1000. grams = | <u>40.0</u>                  | 1000.0                       |
|                  |       |                 | 1000.0 grams                 |                              |

Employing the weights calculated above:

- (1) Make three 1000.0 gram mixes in accordance with Test Method Tex-205-F.
- (2) Mold the three mixes in accordance with Test Method Tex-206-F. Be sure the height of each specimen is 2.00 inches plus or minus 0.06 inch.
- (3) Determine the density of the three molded specimens in accordance with Test Method Tex-207-F. The use of paraffin will be optional.
- (4) Package the three molded specimens carefully and ship them to the Austin Laboratory for stability tests. Form CX-101, Identification Slip For Asphaltic Concrete is to be properly prepared and is to accompany each set of specimens for proper identification.

The above procedure is followed in designing the 1000 gram mixtures for Mixes 2, 3, 4 and 5.

Assume that the following average values were obtained for the five laboratory designs made:

Summary of Test Data

| 1.<br>Mix<br>No. | 2.<br>Asphalt<br>Content<br>(% by Wt.) | 3.<br>Actual Sp.Gr.<br>of Specimens<br>(G <sub>a</sub> ) | 4.<br>Theo.Sp.Gr.<br>Specimens<br>(G <sub>t</sub> )* | 5.<br>Density (%)<br>( $\frac{G_a}{G_t}$ ) x 100% | 6.<br>Stability<br>(%) |
|------------------|--|--|--|---|------------------------|
| 1                | 4.0                                    | 2.200  | 2.430  | 90.5  | 42                     |
| 2                | 5.0                                    | 2.223  | 2.396  | 92.8  | 46                     |
| 3                | 6.0                                    | 2.247  | 2.362  | 95.1  | 45                     |
| 4                | 7.0                                    | 2.271  | 2.330  | 97.5  | 43                     |
| 5                | 8.0                                    | 2.296  | 2.298  | 99.9  | 21                     |

\*In calculating the theoretical specific gravity of the mixes, a bulk specific gravity of 2.579 was determined for the combined aggregates and a specific gravity of 1.020 was determined for the asphalt.

The intent of this design procedure is to make five laboratory mixes ranging from 94 to 99 per cent density. The densities of the above five mixes satisfy this condition. In the event the minimum asphalt content of the governing specifications produces a mix having a density of 94 per cent or more, it would be well to design a mix containing less than the minimum specified. In some instances it is advisable to determine the density of Mix No. 1 before making the other four mixes. As a rule of thumb each 1.0 per cent asphalt will change the density approximately 2.4 per cent.

Plot the per cent by weight of Asphalt (Column 2) against the per cent of Density (Column 5) as shown in the upper part of Graph 1 (Page 11).

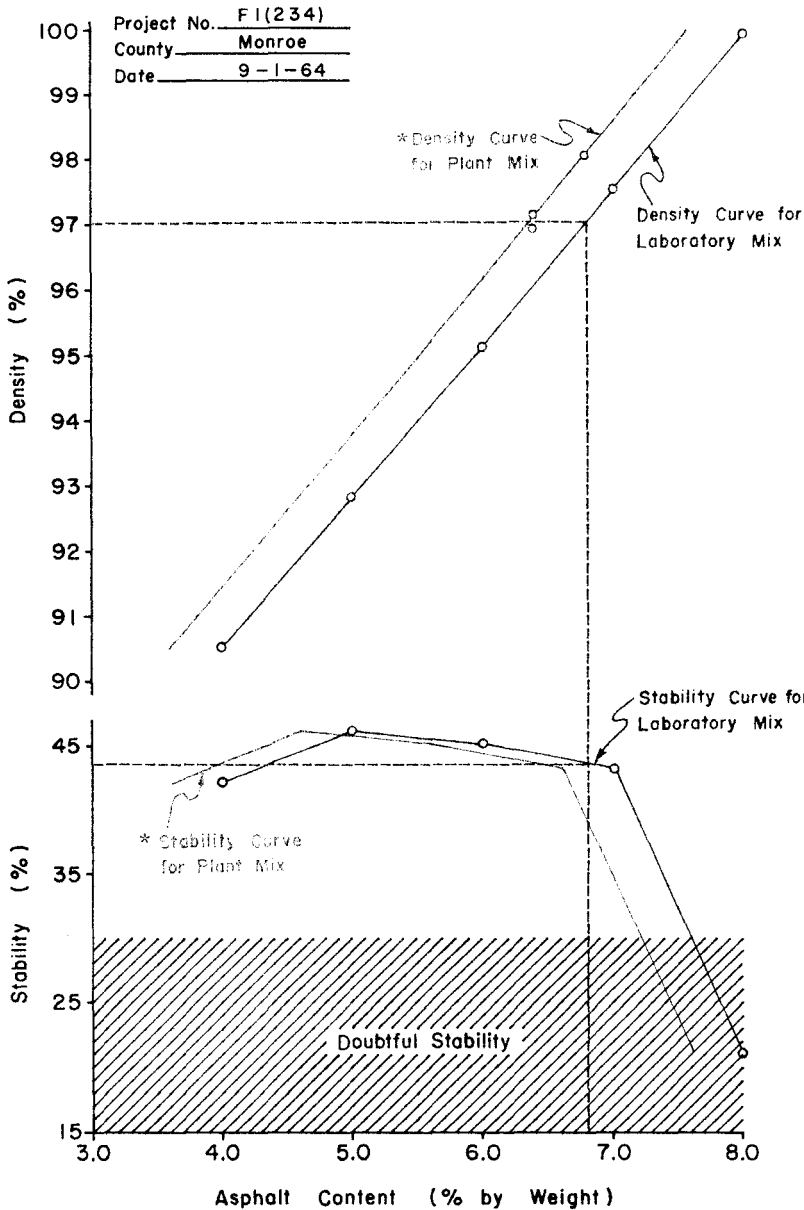
Plot the per cent by weight of Asphalt (Column 2) against the per cent of Stability (Column 6) as shown in the lower part of Graph 1.

The procedure for selecting the asphalt contents for trial mixes suggested above is basically for field personnel without any previous experience with the aggregates that are proposed for use on the project. In areas where similar aggregates have been used on previous projects, the Engineer, being acquainted with the approximate range of asphalt contents required to produce a satisfactory curve, may elect to use asphalt contents on the trial mixes closer to the estimated optimum asphalt content provided that the asphalt contents are increased until the stability becomes less than the specified minimum value. In this case he should have at least two trial mixes below and two trial mixes above his estimated optimum asphalt content. In either case, when time permits, a trial mix using the optimum asphalt content obtained from the curve should be made and submitted as a check on the original curve.

The following requirements for density and stability should be satisfied:

| Type of Mixture         | Density (%) |      |         | Stability (%)   |
|-------------------------|-------------|------|---------|---|
|                         | Min.        | Max. | Optimum | Min.  |
| Hot-Mix Asphaltic Conc. | 94.0        | 99.0 | 97.0    | Not less than 30 unless otherwise shown on the plans. |

Density-Stability Curve



Graph No. 1

\*After starting the plant operations and the laboratory density of the plant mix has been determined, draw a curve through the established density and parallel to the laboratory mix density curve on the laboratory Inspector's copy of the graph. The new density curve will have the same relationship to the stability curve as the original density curve, therefore, the stability curve should be shifted the same horizontal distance as the density curve and in the same direction. The plant mix density curve and stability curve will then be used for job control of the mixture. The density values used in drawing the Plant Mix Density Curve were taken from Construction Form No. 404 Rev.(2) on Page 42.

vertical line that intersects the asphalt content line. This is illustrated by the broken line in Graph 1, and determines the per cent by weight of asphalt required to produce 97.0 per cent density. This percentage is referred to as the optimum asphalt content for the type and grading of aggregate used. In this example, the optimum asphalt content is 6.8 per cent by weight.

Where the optimum asphalt line intersects the stability curve, draw a horizontal line that will intersect the stability line and thus determine the per cent stability that the optimum asphalt content will produce. In Graph 1 this value is 43 per cent.

It may occur that the stability value will be less than 30 per cent. In this event it will be necessary to re-design using different percentages of the various aggregates, so that the minimum stability will be obtained when using the optimum asphalt content. In case there is no combination of proposed aggregates and asphalt within the specification limits that will produce the minimum stability at the optimum asphalt content, it will be satisfactory to design at a lower density than the optimum density. Should it require a density more than 1.5 per cent lower than optimum density to produce the minimum stability, other aggregates should be used.

When the stability curve is fairly flat and all corresponding stability values are well above the minimum of 30, it is permissible to design slightly above the optimum density specified, as all mixtures should contain as high a percentage of asphalt as possible, commensurate with the requirements of density and stability.

A few pertinent remarks regarding our stability test may help in the design of various asphaltic concrete mixtures and prevent some of the mistakes which have occurred in the past.

The stability test as we know it is a modification of A.S.T.M. Designation: D 1560-58T. A.S.T.M. Designation: D 1560-58T was developed by Mr. F. N. Hveem of the California Division of Highways. Essentially, the test measures the shearing resistance of the mixture at 140°F. due primarily to the internal friction of the aggregates, under certain lateral pressures. The 140°F. at which the test is made more or less duplicates the temperature which the pavement reaches on a hot day. However, the lateral pressures used when making the test do not duplicate the lateral pressures in the pavement, particularly in the surface. Due to these lateral pressures, the test does not differentiate between various grades of asphalt, and AC-5 asphalt gives as good a stability as AC-20 asphalt. If the test were made using zero lateral pressure, stability values would be different for the various grades of asphalt, with the heavier asphalts having a substantially higher stability than the lighter asphalts. This explains why some of our pavements have corrugated when using relatively light asphalts even though the stability values for the mixtures were well above the established minimum value. For this reason, it is recommended that asphalts lighter than AC-20 not be used for Hot Mix Asphaltic Concrete Mixtures.

On those projects where a minimum cohesiometer value is specified, it will be necessary for the asphaltic concrete mixture to satisfy this requirement, in addition to the requirements for density and stability.



## INTRODUCTION

Many asphaltic concrete mixtures would appear to have sufficient asphalt on the basis of their total asphalt content or laboratory densities, when, in reality, they are deficient because part of the asphalt cement has been absorbed by the mineral aggregate. Unless adequate corrections are made for this absorption, it would be difficult, in some instances, to design a mixture having the desired asphalt content.

Two main factors other than physical characteristics of the aggregates which influence absorption are heat and time. It is not the intent of this procedure to determine exactly how much asphalt a given aggregate will absorb during a definite length of time and under certain temperatures. The main purpose of this procedure is to be able to make adequate corrections in the quantity of asphalt, due to the absorption of some of the asphalt, so that the life of the pavement is not materially reduced. The allowance for absorption is to be optional with the Engineer, however, it is recommended that allowance not be made when using a light asphalt cement.

Probably the first indication of whether an aggregate will absorb an appreciable amount of asphalt will be reflected in the per cent of water absorption as shown by Test Method Tex-201-F. Should this test result in an absorption of two per cent or greater, then consideration should be given to determining the approximate amount of asphalt that the aggregate will absorb, and corrections should be made in the mix design for this absorption. If an aggregate is suspected of absorbing an appreciable amount of asphalt or if experience indicates the aggregate will absorb an appreciable amount of asphalt, it will be well to determine this absorption by the procedure shown in this Bulletin. It is recommended that correction not be made for an asphalt absorption of one-half per cent or less.

The procedure presented in this Bulletin for determining the approximate amount of this absorption and the method of correcting the mix design is relatively simple and does not require additional field laboratory equipment. It was developed by Mr. J. Rogers Martin, a former employee of the Texas Highway Department and now a Consulting Engineer in Oklahoma City, Oklahoma.

This procedure is based on the fact that if the aggregates absorb an appreciable amount of asphalt, and if the bulk specific gravities are not corrected for this absorption, the laboratory densities will exceed 100 per cent. At some asphalt content, the laboratory density curve will level out, and the actual specific gravity of the molded specimens will decrease, which indicates that the maximum amount of asphalt has been absorbed, that all of the voids in the molded specimens have been filled with asphalt and that the mixture is in a saturated condition. This saturated condition must be satisfied in order to determine the effective specific gravity of the combined aggregates. In order to determine this value, mixes with higher asphalt contents than normally used must be designed and mixed, specimens molded, and the actual specific gravities of the molded specimens determined. The only departure from the standard procedure of design, mixing and molding labora-

the specimens. This action more or less duplicates actual job conditions and satisfies the absorption factors of time and heat in a practical manner.

### DESIGN PROCEDURE

Let us assume that the aggregates proposed for a Type "D" Mix under standard specifications had a water absorption value of 4.2 per cent when tested in accordance with Test Method Tex-201-F. This test result indicates that there will probably be an appreciable amount of asphalt absorbed by the aggregate, so it becomes desirable to determine the effective specific gravity of the combined aggregates and the per cent of absorption. The following steps are involved:

- (1.) Select the aggregate grading as previously outlined.
- (2.) Design the laboratory mixes as previously explained, however design five mixes with asphalt contents of 6.0, 7.0, 8.0, 9.0 and 10.0 per cent. Please note that in this series of mixes, the minimum asphalt content was selected at the midpoint of the specification requirements. This selection was based upon the estimated amount of asphalt that would be absorbed.
- (3.) Make three 1000 gram mixes in accordance with Test Method Tex-205-F for each asphalt content.
- (4.) After thoroughly mixing the asphalt and aggregate for each of the mixes, place the mixing pan containing the mixture in an oven and maintain the mixture at a temperature of approximately 250°F. for two hours.
- (5.) Mold three specimens for each asphalt content in accordance with Test Method Tex-206-F.
- (6.) Determine the specific gravity and density of the three molded specimens of each asphalt content in accordance with Test Method Tex-207-F. The use of paraffin will be optional.
- (7.) Package the three molded specimens carefully and ship them to the Austin Laboratory for stability tests. Form CX-101, Identification Slip for Asphaltic Concrete, is to be properly prepared and is to accompany each set of specimens for proper identification.

Assume that the following average values were obtained for the five laboratory designs made:

#### Summary of Test Data

| 1.      | 2.                         | 3.                                   | 4.                                  | 5.   | 6.            |
|---------|----------------------------|--------------------------------------|-------------------------------------|--|---------------|
| Mix No. | Asphalt Content (% by Wt.) | Actual Sp.Gr. of Specimens ( $G_a$ ) | Theo.Sp.Gr. of Specimens ( $G_t$ )* | Uncorrected Density $\frac{G_a}{(G_t)} \times 100\%$ | Stability (%) |
| 1       | 6.0                        | 2.262                                | 2.362                               | 95.8   | 46            |
| 2       | 7.0                        | 2.287                                | 2.330                               | 98.2   | 45            |
| 3       | 8.0                        | 2.312                                | 2.298                               | 100.6  | 48            |
| 4       | 9.0                        | 2.337                                | 2.267                               | 103.1  | 27            |
| 5       | 10.0                       | 2.304                                | 2.237                               | 103.0  | 18            |

gravity of 1.020 was determined for the asphalt.

From the above test data, the mix containing 9.0 per cent asphalt has an actual specific gravity of 2.337 and the mix containing 10.0 per cent asphalt has an actual specific gravity of 2.304. In calculating the effective specific gravity of the combined aggregates, always use the actual specific gravity value which follows the highest actual specific gravity value, and which, in this case, is 2.304. This is necessary because the highest specific gravity value usually will not occur at the saturation point, however, in this example this did happen.

Determine the effective specific gravity of the combined aggregates by the following formula:

$$G_e = \frac{100 - A_s}{\frac{100}{G_a} - \frac{A_s}{G_s}}$$

Where:  $G_e$  = Effective specific gravity of the combined aggregates in the molded specimen

$G_a$  = Actual specific gravity of the molded specimen saturated with asphalt

$G_s$  = Specific gravity of asphalt

$A_s$  = Per cent by weight of asphalt in specimen

$G_e$  should never be less than the bulk specific gravity of the combined aggregates nor greater than the specific gravity of the combined aggregates in a saturated surface dry condition.

In this example we know that Mix No. 5 is in a saturated condition and all of the voids have been filled with asphalt because the actual specific gravity of the molded specimens in this mix is less than the actual specific gravity of the molded specimens in Mix No. 4. Then, in this case:

$$G_e = \frac{100.0 - 10.0}{\frac{100.0}{2.304} - \frac{10.0}{1.020}} = 2.679$$

If the per cent of absorption is desired, calculate this value by the following formula:

$$A_b = \left( \frac{1}{G_b} - \frac{1}{G_e} \right) G_s \times 100$$

Where:  $A_b$  = Per cent by weight of asphalt absorbed based on the weight of aggregate

$G_b$  = Bulk specific gravity of the combined aggregates

$G_e$  = Effective specific gravity of the combined aggregates

$G_s$  = Specific gravity of asphalt

In this example,

$$A_b = \left( \frac{1}{2.579} - \frac{1}{2.679} \right) 1.020 \times 100 = 1.5 \text{ per cent}$$

the following formula:

$$G_t = \frac{100}{\frac{A_g}{G_e} + \frac{A_s}{G_s}}$$

Where:  $G_t$  = Theoretical specific gravity of the mixture after absorption

$G_e$  = Effective specific gravity of the combined aggregates

$G_s$  = Specific gravity of the asphalt

$A_g$  = Per cent by weight of aggregate in the mixture

$A_s$  = Per cent by weight of asphalt in the mixture

For example, we will select Mix No. 3 which consisted of 8.0 per cent by weight of asphalt and 92.0 per cent by weight of aggregate. Then,

$$G_t = \frac{100}{\frac{92.0}{2.679} + \frac{8.0}{1.020}} = 2.371$$

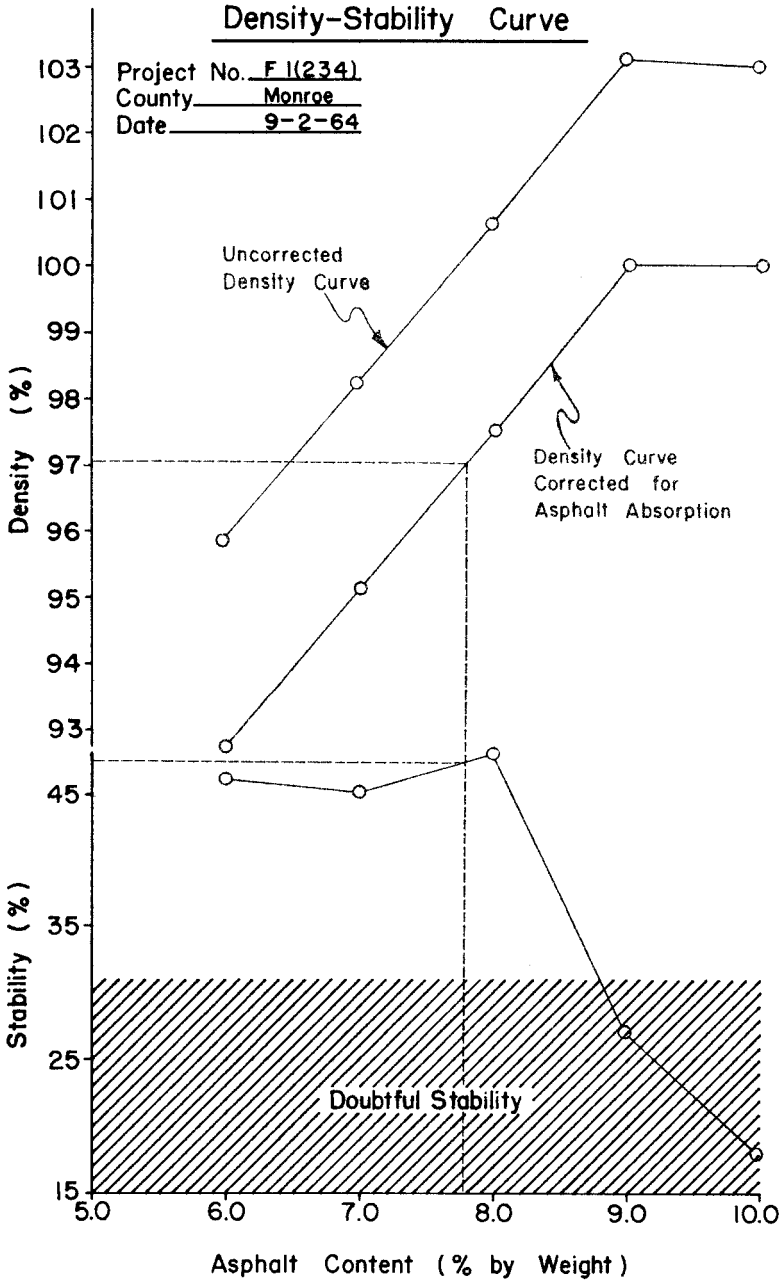
Recalculate the theoretical specific gravities of the five mixes as shown above and determine the density of the laboratory specimens based on these values as shown in the following summary:

Summary of Test Data  
(After Absorption)

| 1.      | 2.                         | 3.                                   | 4.                                 | 5.  | 6.            |
|---------|----------------------------|--------------------------------------|------------------------------------|---|---------------|
| Mix No. | Asphalt Content (% by Wt.) | Actual Sp.Gr. of Specimens ( $G_a$ ) | Theo.Sp.Gr. of Specimens ( $G_t$ ) | Corrected Density ( $\frac{G_a}{G_t}$ )x 100.0% | Stability (%) |
| 1       | 6.0                        | 2.262                                | 2.441                              | 92.7  | 46            |
| 2       | 7.0                        | 2.287                                | 2.405                              | 95.1  | 45            |
| 3       | 8.0                        | 2.312                                | 2.371                              | 97.5  | 48            |
| 4       | 9.0                        | 2.337                                | 2.337                              | 100.0   | 27            |
| 5       | 10.0                       | 2.304                                | 2.304                              | 100.0   | 18            |

Plot the test results of this summary in addition to the summary shown on Page 14 in accordance with previous instructions and as illustrated in Graph 2 (Page 17), and select the optimum asphalt content as previously explained.

In allowing for absorption of asphalt by the aggregates, the Engineer should take the following precautions:



Graph No. 2

If it is necessary to revise the Density-Stability Curve for the plant mix, see the instructions and the example shown on Page 11.

starting plant operations and under actual plant operation conditions. This will provide additional evidence that the preliminary samples were truly representative.

2. It is preferable that laboratory densities not exceed the optimum density, due to the variable characteristics of the aggregates.
3. In molding the specimens for density and stability determinations, the same procedure must be used as was used to mold the specimens for determining the absorption. (Maintain the mixes at a temperature of approximately 250° F. for a period of two hours before molding).
4. Since moisture free aggregates will absorb more asphalt than aggregates containing a small amount of internal moisture, it is important that the aggregates be thoroughly dried immediately after rains. In some cases it may be necessary to slightly reduce the amount of asphalt allowed for absorption. In these cases, the mix should be carefully observed and the density carefully checked.
5. When the mixture is to be placed on a project carrying heavy traffic and a high traffic count, it may be necessary to reduce the amount of asphalt allowed for absorption because the amount and the type of traffic may over-compact the mixture before absorption takes place, resulting in an unstable pavement. This condition is more likely to occur during hot weather than in cold weather.

### DETERMINATION OF BATCH WEIGHTS

The design selected for starting the paving plant should (in the example assumed) contain 6.8 per cent asphalt by weight and 93.2 per cent by weight of aggregate of the same grading selected in making the laboratory mixtures (See Graph 1 on Page 11). This mixture will have the following analysis:

| <u>Size</u> | Grading Analysis<br>Total Aggregate<br>(% by Weight) |   |         | Grading Analysis<br>of Paving Mixture<br>Selected<br>(% by Weight) |
|-------------|--|---|---------|--|
| 1/2" - 3/8" | 1.4  | x | 0.932   | 1.3  |
| 3/8" - 4    | 39.6   | x | 0.932   | 36.9   |
| 4 - 10      | 23.9   | x | 0.932   | <u>22.3</u> - 60.5   |
| 10 - 40     | 14.0   | x | 0.932   | 13.0   |
| 40 - 80     | 10.8   | x | 0.932   | 10.1   |
| 80 - 200    | 6.9  | x | 0.932   | 6.4  |
| Pass 200    | <u>3.4</u>   | x | 0.932   | <u>3.2</u>   |
|             | 100.0  |   |         | 93.2   |
|             |  |   | Asphalt | <u>6.8</u>   |
|             |  |   |         | 100.0  |

Revised: March, 1968

Texas Highway Department  
Construction Form No. 544 Rev. (2)

TEXAS HIGHWAY DEPARTMENT  
ASPHALTIC CONCRETE SIEVE ANALYSIS WORK SHEET

County Monroe Highway S. H. 2000 Project F 1(234) Control 5-6-7  
Date 9-4-67 Time \_\_\_\_\_ Station \_\_\_\_\_ Sampled By \_\_\_\_\_  
Spec. Item 340 Type D Design No./Tripl. No. \_\_\_\_\_

| Sieve Size    | Bin No. 1 (a)  |         |       | Bin No. 2 (b)  |         |       | Bin No. 3 (c)  |         |       | Bin No. 4 (d)  |         |   | Combined Analysis % (a+b+c+d) |
|---------------|----------------|---------|-------|----------------|---------|-------|----------------|---------|-------|----------------|---------|---|-------------------------------|
|               | Weight (grams) | Total % | %     | Weight (grams) | Total % | %     | Weight (grams) | Total % | %     | Weight (grams) | Total % | % |                               |
| 1 1/2" - 3/4" |                |         |       |                |         |       |                |         |       |                |         |   |                               |
| 3/4" - 1/2"   |                |         |       |                |         |       |                |         |       |                |         |   |                               |
| 1/2" - 3/8"   |                |         |       |                |         |       |                |         |       |                |         |   |                               |
| 3/8" - 4"     |                |         |       | 53             | 6.7     | 1.5   | 1326           | 89.5    | 35.8  |                |         |   | 1.4                           |
| 1/4" - 10"    |                |         |       |                |         |       |                |         |       |                |         |   | 1.3                           |
| 4 - 10"       | 36             | 8.3     | 2.6   | 683            | 86.4    | 19.4  | 34             | 2.3     | 0.9   |                |         |   | 22.9                          |
| + 10"         |                |         | 2.6   |                |         | 20.9  |                |         | 38.1  |                |         |   | 61.6                          |
| 10 - 40"      | 153            | 35.1    | 10.8  | 32             | 4.0     | 0.9   | 24             | 1.6     | 0.6   |                |         |   | 12.3                          |
| 40 - 80"      | 143            | 32.8    | 10.1  | 6              | 0.8     | 0.2   | 13             | 0.9     | 0.4   |                |         |   | 10.7                          |
| 80 - 200"     | 73             | 16.7    | 5.1   | 9              | 1.1     | 0.2   | 13             | 0.9     | 0.4   |                |         |   | 5.7                           |
| Pass 200"     | 31             | 7.1     | 2.2   | 8              | 1.0     | 0.2   | 18             | 1.2     | 0.5   |                |         |   | 2.9                           |
| Total         | 436 gm         | 100.0%  | 30.8% | 796 gm         | 100.0%  | 22.4% | 1482 gm        | 100.0%  | 40.0% | gm             | 100.0%  | % | 93.2%                         |

| PER CENT MOISTURE IN AGGREGATES IN HOT BINS |                     |                          |                          |                             |                                 |  |
|---|---------------------|--------------------------|--------------------------|-----------------------------|---------------------------------|--|
| Bin No.                                     | (a) Tare Wt. (gms.) | (b) Gross Wet Wt. (gms.) | (c) Gross Dry Wt. (gms.) | (d) Wt. Moist (gms.)<br>b-c | (e) Dry Wt. Aggr. (gms.)<br>c-a | % Moist.<br>$\frac{d}{e} \times 100\%$ |
| 1   |                     |                          |                          |                             |                                 |  |
| 2   |                     |                          |                          |                             |                                 |  |
| 3   |                     |                          |                          |                             |                                 |  |
| 4   |                     |                          |                          |                             |                                 |  |

Asphaltic Binder = 6.8 % 6.8  
Total = 100.0%

*John Lee*  
Inspector

In order to obtain the desired sieve analysis in the completed mix, Aggregates A, B and C must be fed at the cold stone feeder in approximately the same proportions used in designing the laboratory mixtures. The example used in this Bulletin requires 60.0% of Aggregate A, 30.0% of Aggregate B and 10.0% of Aggregate C. Assume that these aggregates are fed in these proportions and that after passing through the dryer, they are screened into three sizes meeting the governing specifications. Assume also that a sieve analysis of each bin size was made in accordance with Test Method Tex-200-F, the results of which are tabulated on Construction Form No. 544 Rev., Page 19. Please note that the grading analysis for each bin meets the grading requirements of the governing specifications.

In the right hand margin of Construction Form No. 544 Rev. tabulate the grading analysis of the paving mixture selected. The amounts of each bin necessary to meet the selected mixture are calculated on this form. It is noted that the total paving mixture will consist of 93.2% aggregate and 6.8% asphalt. The specifications require that three hot bins be used in producing a Type "D" mixture, and the sum of the percentages of aggregate used from the hot bins must equal 93.2%.

In calculating the bin percentages there will be some minor variations from the trial mixes, however, it usually will not affect the mix unless the sieve analysis falls out of the grading tolerances for that type of mixture. Bin No. 2 and Bin No. 3 have one dominant size that will fill most of the percentage of that size in the completed mixture. There will probably be several trials made before a satisfactory percentage of each bin is worked out to be close to the trial mix design. Always begin with Bin No. 3 and try a percentage that, when multiplied by the dominant size in that bin, will give a percentage a little below that of the trial design with the assumption that a small percentage of this size will be secured from Bin No. 2. Use the same method in calculating the percentage of Bin No. 2 keeping in mind the gradation and type of material in the stockpiles. Most of the plus 10 material is secured from Bins No. 2 and 3 and the total plus 10 material should be reasonably close to the trial mix design. Generally setting the percentages of Bin No. 2 and Bin No. 3 as indicated, the balance of percentage required for the mixture is obtained from Bin No. 1 and usually the percentages fall close to the trial mix design. There may be cases where the percentages from the first sieve analysis will give some unrealistic figures and when this occurs this should be discarded and, if necessary, adjust the cold feed gates, clean the hot bins, and secure another sample for sieve analysis and repeat the procedure to secure the percentages of the hot bins.

In this case after several trials, it was found that by using 30.8% out of Bin No. 1, 22.4% out of Bin No. 2 and 40.0% out of Bin No. 3, the combined analysis meets the specifications; and, since the variation from the trial design is well within acceptable limits the calculated combination of bins is satisfactory and the calculation of bin weights can be made.

The batch weights for a weigh plant producing a 2000 pound batch will be:

|           | <u>% by Weight</u> |   | <u>Pounds</u> |
|-----------|--------------------|---|---------------|
| Bin No. 1 | 30.8% x 2000       | = | 616           |
| Bin No. 2 | 22.4% x 2000       | = | 448           |
| Bin No. 3 | 40.0% x 2000       | = | 800           |
| Asphalt   | <u>6.8%</u> x 2000 | = | <u>136</u>    |
|           | 100.0%             |   | 2000          |



In the event a continuous mixing plant is used, give the Contractor the percentage by weight of the various bins and asphalt calculated above. It will be the Contractor's responsibility to set the plant to produce a mixture meeting the selected design. The plant inspector should make numerous extraction tests in accordance with Test Method Tex-210-F to insure that the mixture is meeting the design requirements.

**COLD MIX**  
**LIMESTONE ROCK ASPHALT PAVEMENT**

## COLD MIX LIMESTONE ROCK ASPHALT PAVEMENT

At the present time there are only two suppliers which furnish Cold Mix Limestone Rock Asphalt for Texas highway construction. The limestone rock asphalt is mixed with fluxing material by the suppliers and the completed mixture is shipped ready for use. File D-9 personnel test and reject or approve the materials and the completed mixture at the supplier's plant site; therefore, District personnel will not be charged with designing and controlling Cold Mix Limestone Rock Asphalt Pavement.

The primary responsibility of District personnel will be to determine the quantity in tons of pavement placed. The Specifications allow a maximum water content of four per cent by weight in the mixture at the time it is placed on the roadway. All water in the mixture in excess of four per cent by weight at the time of weighing the mixture on the truck scales shall be deducted in determining the pay quantity. The water content shall be determined in accordance with Test Method Tex-212-F.

**HOT MIX COLD LAID  
ASPHALTIC CONCRETE PAVEMENT**

# HOT MIX COLD LAID ASPHALTIC CONCRETE PAVEMENT

The Standard Specifications permit the placing of the Hot Mix Cold Laid Asphaltic Concrete either in a cold condition or, if a primer and/or water is not added, in a hot condition.

## Hot Mix Cold Laid Asphaltic Concrete Pavement Placed in a Cold Condition

The procedure for designing the mixture is identical to the procedure for designing Hot Mix Asphaltic Concrete Pavement, with the exceptions that no correction is to be made for the absorption of asphalt by the aggregates and it is recommended that the total amount of plus 10 material be maintained at approximately 5% above the minimum per cent allowed by the Standard Specifications. The procedure for controlling the mixture is outlined on Page 33.

The following requirements for laboratory density and stability should be satisfied:

| Density (%) |             |                | <u>Stability (%)</u>                                      |
|-------------|-------------|----------------|---|
| <u>Min.</u> | <u>Max.</u> | <u>Optimum</u> |   |
| 93.0        | 96.0        | 95.0           | Not less than 30 except when otherwise shown on the plans |

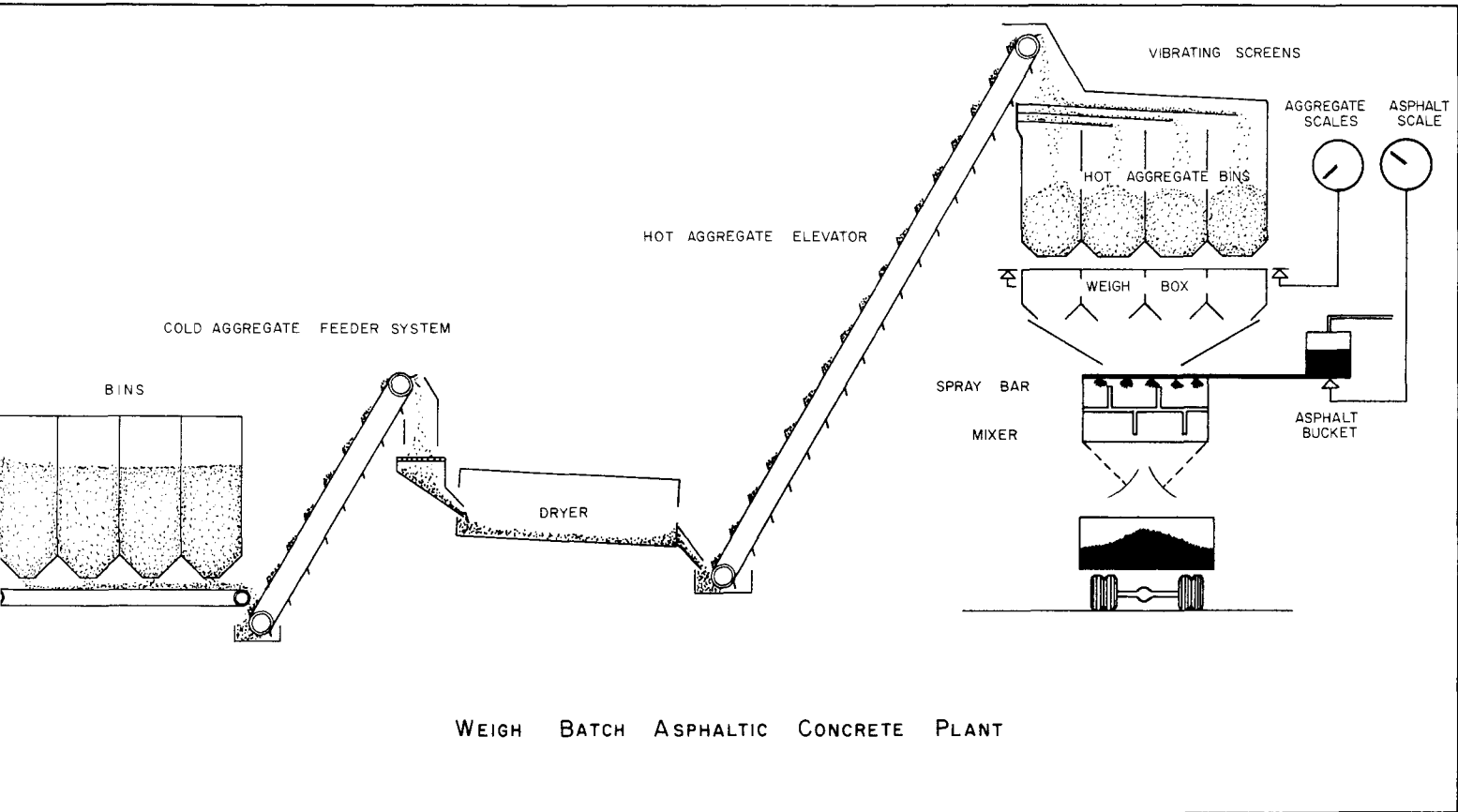
## Hot Mix Cold Laid Asphaltic Concrete Pavement Placed in a Hot Condition

If the Contractor elects to place the Hot Mix Cold Laid Asphaltic Concrete mixture in a hot condition, the mixture shall be designed and controlled in accordance with the procedure presented in this Bulletin for designing and controlling Hot Mix Asphaltic Concrete Pavement. Item 350 and/or Item 352 of the Standard Specifications shall be amended with respect to the clauses cited below. No other clauses or requirements of either Item shall be waived or changed.

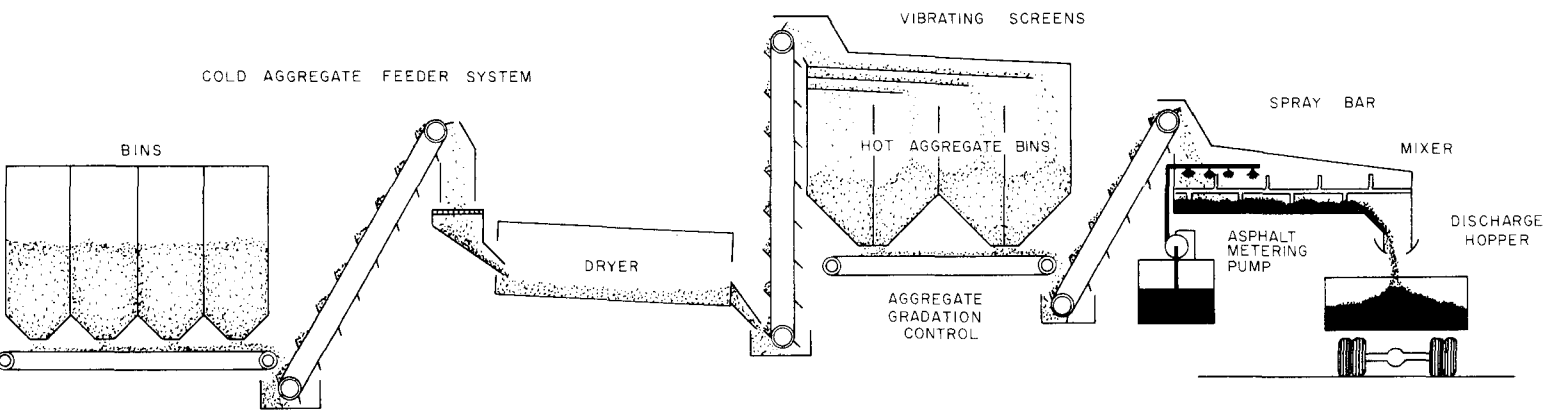
Article 350.1 Description and/or Article 352.1 Description shall be voided and replaced by Article 340.1 Description of Item 340 of the Standard Specifications.

Article 350.5 Stockpiling, Storage, Proportioning, and Mixing Subsection (5) Mixing and/or Article 352.5 Stockpiling, Storage, Proportioning, and Mixing Subsection (5) Mixing shall be voided and replaced by Article 340.5 Stockpiling, Storage, Proportioning, and Mixing Subsection (5) Mixing of Item 340 of the Standard Specifications.

Article 350.6 Construction Methods and/or Article 352.6 Construction Methods shall be voided and replaced by Article 340.6 Construction Methods of Item 340 of the Standard Specifications.



WEIGH BATCH ASPHALTIC CONCRETE PLANT



CONTINUOUS MIXING ASPHALTIC CONCRETE PLANT

# **SAMPLING AND TESTING ON PROJECT**



## **SAMPLING AND TESTING ON PROJECT**

There are two types of sampling and testing involved in the operation of an asphaltic concrete project. Sampling and testing for quality control applies to the ingredients which are used in the asphaltic concrete mixtures. Sampling and testing for job control applies to making certain tests which are used to establish the proportions of the various ingredients used in the asphaltic concrete mixture. In order for the Engineer to clearly understand each type of sampling and testing, they will be discussed separately.

### **QUALITY CONTROL SAMPLING AND TESTING**

These samples and tests are to be made on the ingredients (Mineral Aggregates and Asphaltic Material) proposed for use in the asphaltic concrete mixtures and will be the basis for acceptance or rejection of the ingredients. Frequency of the tests will be determined by the Engineer, and this will depend upon certain characteristics of the material. Borderline material will require more sampling and testing than material well within the specification requirements. When possible, material should be sampled and tested as it arrives at the plant site and should not be retested because of any change which may occur due to normal or ordinary operations of the plant. Any change in the material due to contamination by foreign material or an accumulation of objectionable material will be sufficient cause for retesting and rejection if so determined by the Engineer.

### **JOB CONTROL SAMPLING AND TESTING**

These samples and tests are provided to determine the proportions of the various ingredients to use in the asphaltic concrete mixtures. Certain values are established in the governing specifications, and whenever it is determined that the mixture does not meet these established values due to the design, corrective action is to be taken until it does.

At the beginning of any project, the grading design was based on supposedly representative preliminary samples of the aggregates. In some instances these preliminary samples will not be truly representative, in which case changes should be made in the applicable sieve sizes of the grading design to prevent certain aggregate sizes from being wasted and to correlate the design grading with the actual grading of the mixture. It may be necessary to follow this procedure several times during a project due to changes in the gradation of the various aggregates. As previously stated in this Bulletin, usually the controlling gradation of a mixture is the per cent of material retained on and passing the No. 10 mesh sieve, and as long as these percentages remain fairly constant, one mixture is as good as any other provided each sieve size is of the same material. Naturally this would not be true if, for instance, the 3/8 to No. 4 material was pea-gravel and the No. 4 to No. 10 material was crushed stone, say in a Type "D" mixture.

If the source of any of the ingredients in the asphaltic concrete mixture is changed, preliminary designs and tests will be required before using the ingredient(s).

A minimum number of job control tests are established which should secure for a normal project a uniform mixture of asphaltic concrete meeting the values established in the specifications most of the time. There will be instances when more tests should be made.

### **SCHEDULE OF MINIMUM REQUIREMENTS FOR JOB CONTROL TESTS**

- I. Submit one copy of the "Density-Stability Curve" proposed for use on the project to File D-6 with the first weekly submission of Construction Form No. 404 Rev.(2), Daily Construction Report-Asphaltic Concrete Pavement. List the sieve analysis that was used in making the design specimens on the back of the "Density-Stability Curve."
- II. Daily Requirements for Full Day's Operation
  - A. Hot Mix Asphaltic Concrete Pavement
    1. Sampling
      - a. Aggregate
        - (1.) Weigh Batch Plants. Samples must be taken from each individual hot bin and must be taken diligently so that a truly representative sample will be secured. The container used to take these samples must be of ample width to cover the total width of the hot bin discharge opening.
        - (2.) Continuous Mix Plants. The physical characteristics of a continuous mix plant prevent sampling of the hot bins, therefore, analyses of the hot bins will not be required. Under certain conditions, however, it may be necessary or desirable for the hot bins to be recalibrated in accordance with the manufacturer's instructions.
      - b. Hot Mix Asphaltic Concrete Mixture
        - (1.) Weigh Batch Plants. The mixture is to be sampled at least once each day and the sample must be large enough, after being properly quartered, to make an extraction and to mold specimens for a laboratory density and stability determination. Here again, a truly representative sample must be taken. The Engineer has the option of taking the samples at the plant from a truck or from the roadway; however, it is preferable to take the sample from the roadway. Roadway samples may be taken from a truck just prior to dumping into the paver, from various points immediately behind the paver after approximately one-half of the truck-load has passed through the paver, or from any point in between these two points that will afford a representative sample. Any sample taken from a truck shall be taken from at least four points, approximately 12 inches below the surface, so distributed over the truck that they are near the midpoint of each quarter of the truck bed area.

- (2.) Continuous Mix Plants. The mixture is to be sampled in accordance with the instructions given for Weigh Batch Plants, with the exception that at least two additional samples, of smaller size, are to be taken daily for making two additional extractions.

## 2. Testing

### a. Weigh Batch Plants

- (1.) Make four combined sieve analyses of the hot bins in accordance with previous instructions of this Bulletin. Record all of this data on Construction Form No. 544 Rev. and record the results on Construction Form No. 404 Rev. Compare these combined sieve analyses with the design sieve analysis, and if necessary, adjust the weights of the hot bins so that the mixture will be within the Specification tolerances. If adjustment of the weights of the hot bins does not correct the discrepancy, adjust the design per cent of each sieve size so that the mixture will be within the Specification tolerances, keeping in mind that the total design per cent retained on the 10 mesh sieve is to be maintained.
- (2.) Make one extraction test in accordance with Test Method Tex-210-F. Record all of the data on Form No. 546 Rev. and record the results on Construction Form No. 404 Rev. Compare and correlate the sieve analysis of the extraction test with the combined sieve analyses of the hot bins and the design sieve analysis. When there is too great a discrepancy in the results of the extraction sieve analysis and the combined hot bins sieve analyses, either the Contractor's weigher is not weighing the proper amount of material out of each bin, or the Inspector is not taking representative samples out of the hot bins. Determine the cause of the discrepancy and make the proper changes so that all of the sieve analyses will be correlated.
- (3.) Mold one set of specimens for density and stability determinations in accordance with Test Method Tex-206-F. Determine the density in accordance with Test Method Tex-207-F. Record all of the data on Construction Form No. 545 Rev. and record the results on Construction Form No. 404 Rev. With the aggregate gradation desired, increase the asphalt content if the density is lower than desired, or decrease the asphalt content if the density is greater than desired. For those curves where the stability is satisfactory at a density greater than 98, it is recommended that the density of the job control specimens be designed to never exceed the density, less one, on the design density curve at which point the stability becomes less than the value established in the specifications. In order to comply with this recommendation, the asphalt content at which the stability becomes less than

the minimum stability specified should be determined. With the same asphalt content and aggregates, the laboratory densities of plant mixes will usually be from one-half to one per cent higher than the laboratory densities of laboratory mixes.

If the stability of the job control specimens is less than the established value, try to determine the cause and take the proper action. Some of the factors which may cause low stabilities are as follows:

- (a.) Density too high as a result of the asphalt content being too high.
- (b.) Molding procedure or technique not in accordance with test procedure.
- (c.) Inside of molding cylinder worn too much which causes the specimen to be fractured as it is extruded from the mold.
- (d.) Base plate and compression ram fit too loosely in molding cylinder which causes extruded or rough edges.
- (e.) Rough handling of test specimens (Never pack or ship test specimens until they have thoroughly cooled).
- (f.) Rough edges and/or large voids on edges of specimens.
- (g.) Head of compression ram not parallel with platen or jack.
- (h.) Pressure gauge or jack out of order.
- (i.) If used, a small amount of paraffin left on specimen.
- (j.) If the cause for repeated low stabilities cannot be determined and corrected, suspend plant operations, design a new mix, and prove the new design by tests before resuming plant operations. Contact the Construction Division for assistance, if needed.

#### b. Continuous Mix Plants

- (1.) Make three extraction tests in accordance with Test Method Tex-210-F. Record the data on Form No. 546 Rev. and record the results on Construction Form No. 404 Rev. Compare and correlate the extraction sieve analyses with the design sieve analysis, and, if necessary, have the Contractor adjust the plant so that the mixture will be within the Specification tolerances. If adjusting the plant does not correct the discrepancy, adjust the design per cent of each sieve size so that the mixture will be within the Specification tolerances, keeping in mind that the total design per cent retained on the 10 mesh sieve is to be maintained.

- (2.) Mold one set of specimens for density and stability determinations in accordance with the instructions given for Weigh Batch Plants.

## B. Cold Mix Limestone Rock Asphalt Pavement

1. Sampling. Samples of the mixture are to be taken in accordance with Test Method Tex-222-F.
2. Testing. The water content of the mixture shall be determined in accordance with Test Method Tex-212-F. The water content shall be determined for approximately each 200 tons. A minimum of one sample shall be taken for each day's run.

## C. Hot Mix Cold Laid Asphaltic Concrete Pavement Placed Cold

### 1. Sampling

#### a. Aggregate

- (1.) Weigh Batch Plants. Aggregates samples are to be taken in accordance with the instructions given under Hot Mix Asphaltic Concrete Pavement.
- (2.) Continuous Mix Plants. Follow the instructions given for Continuous Mix Plants under Hot Mix Asphaltic Concrete Pavement.

#### b. Hot Mix Cold Laid Asphalt Concrete Mixture

- (1.) Weigh Batch Plants. The mixture is to be sampled at least once each day and the sample must be large enough, after being properly quartered, to make an extraction and to mold specimens for a laboratory density and stability determination from the same sample. The sample or samples of the mixture shall be taken in accordance with Test Method Tex-222-F.
- (2.) Continuous Mix Plants. The mixture is to be sampled in accordance with the instructions given for Weigh Batch Plants, with the exception that at least two additional samples, of smaller size, are to be taken daily for making two additional extractions.

### 2. Testing

#### a. Weigh Batch Plants

- (1.) Make four combined sieve analyses in accordance with the instructions given for Weigh Batch Plants under Hot Mix Asphaltic Concrete Pavement.

- (2.) Make one moisture content determination in accordance with Test Method Tex-212-F and record the results on Form No. 546 Rev.
- (3.) Make one hydrocarbon volatile content determination in accordance with Test Method Tex-213-F and record the results on Form No. 546 Rev.
- (4.) Make one extraction test in accordance with the instructions given for Weigh Batch Plants under Hot Mix Asphaltic Concrete Pavement.
- (5.) Mold one set of specimens for density and stability determinations in accordance with the instructions given for Weigh Batch Plants under Hot Mix Asphaltic Concrete Pavement.

b. Continuous Mix Plants

- (1.) Make three moisture content determinations in accordance with Test Method Tex-212-F and record the results on Form No. 546 Rev.
- (2.) Make three hydrocarbon volatile content determinations in accordance with Test Method Tex-213-F and record the results on Form No. 546 Rev.
- (3.) Make three extraction tests in accordance with the instructions given for Continuous Mix Plants under Hot Mix Asphaltic Concrete Pavement.
- (4.) Mold one set of specimens in accordance with the instructions given for Weigh Batch Plants under Hot Mix Asphaltic Concrete Pavement.

D. Hot Mix Cold Laid Asphaltic Concrete Pavement Placed Hot. The aggregates and the mixture are to be sampled and tested in exact accordance with the instructions given for Hot Mix Asphaltic Concrete Pavement.

**DEFINITIONS**  
**WORK SHEETS AND REPORT FORMS**  
**EQUIPMENT**

## DEFINITIONS

ASPHALTIC CONCRETE is a combination of granular particles, usually called mineral aggregates, and asphalt cement.

COARSE AGGREGATE is that portion of the aggregate which is retained on the No. 10 sieve and consists of clean, tough, durable fragments of stone, crushed blast furnace slag, crushed gravel, gravel, shell, or combinations thereof.

FINE AGGREGATE is that portion of the aggregate which passes the No. 10 sieve and consists of sand, durable stone particles free from injurious foreign matter, screenings composed of the same or similar material as specified for coarse aggregate, or a combination thereof.

MINERAL FILLER consists of thoroughly dry stone dust, slate dust, portland cement or other mineral dust all of which must be free from foreign or injurious matter.

FLUX OR FLUX OIL is liquid asphaltic material used to give natural asphalt or refined petroleum asphalt, which is too hard in consistency or fuses at too high a temperature, the desired physical characteristics.

SATURATED SURFACE DRY is the condition of an aggregate particle when its interior permeable pores are completely saturated with water and its surface is dry.

BULK SPECIFIC GRAVITY is the ratio of the oven-dry weight of a given absolute volume of material to the weight of an equal volume of water.

EFFECTIVE SPECIFIC GRAVITY is the bulk specific gravity value increased due to absorption of the asphalt by the aggregates. The values for bulk specific gravity and effective specific gravity are the same if the aggregates do not absorb any asphalt. The effective specific gravity can never be less than the bulk specific gravity nor more than the saturated surface dry specific gravity.

THEORETICAL SPECIFIC GRAVITY is the specific gravity of the asphaltic concrete mixture calculated from known values of the per cent and specific gravity of the aggregate and the asphalt and is based on zero air voids. See the formula on Page 5 of Test Method Tex-207-F.

ACTUAL SPECIFIC GRAVITY is the specific gravity of the asphaltic concrete molded specimens as determined in the laboratory by Test Method Tex-207-F.

PER CENT DENSITY is the ratio of the Actual Specific Gravity to the Theoretical Specific Gravity and expressed as per cent.

OPTIMUM DENSITY is the value established by the specifications on the basis of maintaining stability and producing durable asphaltic concrete.



OPTIMUM ASPHALT CONTENT is the asphalt content of an asphaltic concrete mixture at which optimum density occurs.

WATER ABSORPTION is the amount of water absorbed by an aggregate and is expressed as a per cent of the oven-dry weight of that aggregate.

ASPHALT ABSORPTION is the amount of asphalt absorbed by an aggregate and is expressed as a per cent of the oven-dry weight of that aggregate.

STABILITY is the ability of compacted asphaltic concrete to resist lateral deformation under a vertically applied load.

COHESIOMETER VALUE is a measure of the ability of compacted asphaltic concrete to resist tensile stress. In general, a brittle asphaltic concrete pavement has a lower cohesiometer value than a flexible asphaltic concrete pavement has.

DURABILITY is the ability of an asphaltic concrete pavement to withstand the effect of weather and traffic and to retain the properties which are desirable, i.e., stability, density, and surface texture.

WORKABILITY is a relative measure and refers to the ease with which an asphaltic concrete mix spreads, rakes down, and can be compacted.

PRIME COAT is an application of liquid asphalt of low viscosity which penetrates into a non-bituminous surface upon application, serves as a bonding agent and serves to seal the joint between the non-bituminous surface and the asphaltic concrete.

TACK COAT is an application of cut-back asphalt or emulsified asphalt on an existing surface and serves to bond the new asphaltic concrete pavement to the existing surface.

EMULSIFIED ASPHALT is a mixture of asphalt cement, water, and an emulsifying agent which produces an emulsion in which all of the asphalt is dispersed in the form of minute globules in water. When the emulsion breaks or sets up, the water drains away or evaporates leaving the asphalt.

WEIGH BATCH ASPHALTIC CONCRETE PLANT is a plant which produces asphaltic concrete by weighing and mixing only a given size batch at one time, with the weighing and mixing operation being repeated. See sketch on Page 26.

CONTINUOUS MIXING ASPHALTIC CONCRETE PLANT is a plant which feeds aggregate and asphalt into the mixer at a uniform rate and produces asphaltic concrete continuously at a uniform rate. See sketch on Page 27.

## WORK SHEETS AND REPORT FORMS

### CONSTRUCTION FORM NO. 544 REV.(2), ASPHALTIC CONCRETE SIEVE ANALYSIS WORK SHEET

This Form is intended for use in the field laboratory in calculating aggregate combinations for design purposes and in recording combined bin analyses for the aggregates in the hot bins during paving operations. The use of Construction Form No. 544 Rev.(2) in calculating aggregate combinations for design purposes is shown under SELECTION OF AGGREGATE GRADING on Page 6 and also under DETERMINATION OF BATCH WEIGHTS on Page 19.

### CONSTRUCTION FORM NO. 545 REV., ASPHALTIC CONCRETE DATA SHEET ON MOLDED SPECIMENS AND ROAD SAMPLES

This Form is intended to record laboratory data obtained from Test Method Tex-207-F, Determination of Density of Compacted Bituminous Mixtures, pertaining to design specimens and to specimens prepared from road samples taken during paving operations. Note in the examples on Pages 39 and 40 that during paving operations data for road samples taken are to be shown on the date the pavement is placed.

### FORM NO. 546, REV., ASPHALTIC CONCRETE EXTRACTION TEST WORK SHEET

This Form is intended to record all data in making the extraction test, Test Method Tex-210-F. See completed example of this Form on Page 41.

### CONSTRUCTION FORM NO. 404 REV.(2), DAILY CONSTRUCTION REPORT-ASPHALTIC CONCRETE PAVEMENT

This Form is for recording the design, control, construction progress, and other data pertinent to the placing of asphaltic concrete pavement during a day or part of a day.

The sample of Construction Form No. 404 Rev.(2) on Page 42 will help as a guide in preparing this form.

It will be necessary to keep a separate series of reports for each different type of mix. Each series of reports is to be numbered consecutively.

All of the information indicated by the twelve blanks in the heading should be shown on all reports. The county, highway, project, and control on which paving operations are in progress on the date of the report are to be entered in the appropriate spaces. If paving operations for any day are conducted on more than one control-section, that day's report should bear both control-section numbers in the heading to identify both locations of work. Show the Specification Item No. under which the pavement is being placed and show the Type of mix being placed. The "Plant Started" time is the time the plant was first started on the day of the report and the "Plant Stopped" time is the time the plant was last stopped on the day of the report.

In the section immediately beneath the heading and identified as "Location No.," indicate the lane or roadway position of the paving operations as shown in the example. Identify the location of the main lanes and one-way frontage

**TEXAS HIGHWAY DEPARTMENT  
ASPHALTIC CONCRETE DATA SHEET ON MOLDED SPECIMENS  
AND ROAD SAMPLES**

County Monroe Project F 1(234) Control 5-6-7  
 Date 9-2-64 Highway S.H. 2000 Station 70+84  
 Specification Item 340 Type D Design No. I

WITH PARAFFIN

A = Weight of Specimen in Air  
 B = Weight of Specimen + Paraffin in Air  
 C = Weight of Specimen + Paraffin in Water  
 G<sub>p</sub> = Specific Gravity of Paraffin  
 G<sub>t</sub> = Theoretical Specific Gravity of Specimen  
 $D = \text{Actual Volume of Specimen} = B - C - \left( \frac{B - A}{G_p} \right)$   
 $G_a = \text{Actual Specific Gravity of Specimen} = \frac{A}{D}$   
 Density of Specimen (%) =  $\left( \frac{G_a}{G_t} \right) \times 100\%$

WITHOUT PARAFFIN

~~B = Weight of Specimen in Air  
 C = Weight of Specimen in Water  
 G<sub>t</sub> = Theoretical Specific Gravity of Specimen  
 D = Actual Volume of Specimen = B - C  
 G<sub>a</sub> = Actual Specific Gravity of Specimen =  $\frac{B}{D}$   
 Density of Specimen (%) =  $\left( \frac{G_a}{G_t} \right) \times 100\%$~~

DATA AND CALCULATIONS

G<sub>t</sub> 2.336 G<sub>p</sub> 0.89

| Specimen No.                 | Laboratory Specimens |       |       | Road Samples    |                  |
|------------------------------|----------------------|-------|-------|-----------------|------------------|
|                              | 1                    | 2     | 3     | 1               | 2                |
| Spec. Height (in.)           | 1.99                 | 2.02  | 2.00  | 1 $\frac{1}{2}$ | 1 $\frac{3}{16}$ |
| A (gm.)                      | 935.4                | 939.2 | 937.5 | 885.2           | 888.5            |
| B (gm.)                      | 987.5                | 992.4 | 990.2 | 933.5           | 937.6            |
| C (gm.)                      | 520.7                | 521.9 | 521.4 | 491.0           | 492.0            |
| B-C (gm.)                    | 466.8                | 470.5 | 468.8 | 442.5           | 445.6            |
| B-A (gm.)                    | 52.1                 | 53.2  | 52.7  | 48.3            | 49.1             |
| (B-A) / G <sub>p</sub> (cc.) | 58.5                 | 59.8  | 59.2  | 54.3            | 55.2             |
| D (cc.)                      | 408.3                | 410.7 | 409.6 | 388.2           | 390.4            |
| G <sub>a</sub>               | 2.291                | 2.287 | 2.289 | 2.280           | 2.276            |
| Density (%)                  | 98.1                 | 97.9  | 98.0  | 97.6            | 97.4             |

|                                 | Laboratory Specimens | Road Samples |
|---------------------------------|----------------------|--------------|
| Average Actual Specific Gravity | 2.289                | 2.278        |
| Average Density (%)             | 98.0                 | 97.5         |

*John Doe*  
Inspector

## WORK SHEETS AND REPORT FORMS

### CONSTRUCTION FORM NO. 544 REV., ASPHALTIC CONCRETE SIEVE ANALYSIS WORK SHEET

This Form is intended for use in the field laboratory in calculating aggregate combinations for design purposes and also in making sieve analyses during paving operations. The use of Construction Form No. 544 Rev., is shown under Selection of Aggregate Grading and also under Determination of Batch Weights on Pages 6 and 19, respectively.

### CONSTRUCTION FORM NO. 545 REV., ASPHALTIC CONCRETE DATA SHEET ON MOLDED SPECIMENS AND ROAD SAMPLES

This Form is intended to record laboratory data obtained from Test Method Tex-207-F, Determination of Density of Compacted Bituminous Mixtures, pertaining to design specimens and to specimens prepared from road samples taken during paving operations. Note in the examples on Pages 39 and 40 that during paving operations data for road samples taken are to be shown on the date the pavement is placed.

### FORM NO. 546, REV., ASPHALTIC CONCRETE EXTRACTION TEST WORK SHEET

This Form is intended to record all data in making the extraction test, Test Method Tex-210-F. See completed example of this Form on Page 41.

### CONSTRUCTION FORM NO. 404 REV., FIELD LABORATORY REPORT FOR ASPHALTIC CONCRETE

This Form is for recording the design, control, construction progress, and other pertinent data in the placing of asphaltic concrete pavement during a day or part of a day.

It is recommended that a separate series of reports be kept for each of the following conditions:

1. Each different control combined in the same contract.
2. Each different type of mix.
3. Each different course of pavement, even though each course may be of the same type of mix and have the same rate of application.
4. Each different rate of application, even though each rate may be for the same course and of the same type of mix.
5. Main lanes (Shoulders of main lanes, the median, crossovers, deceleration lanes, and acceleration lanes are to be considered as main lanes, unless a separate series of reports is required by the conditions stated above.)







Revised: March, 1968

Texas Highway Department  
Construction Form No. 404 Rev. (2)

TEXAS HIGHWAY DEPARTMENT  
DAILY CONSTRUCTION REPORT—ASPHALTIC CONCRETE PAVEMENT

County Monroe Highway S. H. 2000 Project F 1(234) Control 5-6 87-789  
Location of Plant Cold, Texas Type of Plant Weigh Batch Contractor Hot Top Paving Co.  
Date 9-2-64 Specification Item 340 Type D Plant Started 7:30 A.M. Plant Stopped 4:50 P.M.

|              |   |                                  |   |             |   |                               |   |                               |
|--------------|---|----------------------------------|---|-------------|---|-------------------------------|---|-------------------------------|
| Location No. | 1 | <u>N. B. Main Lane 1 of 3</u>    | 3 | Decel. Lane | 5 | Entr. Ramp                    | 7 | <u>N. B. Main Lane 1 of 3</u> |
|              | 2 | <u>S. B. Fr. Rd. Lane 1 of 2</u> | 4 | Accel. Lane | 6 | <u>N. B. Exit Ramp 110+50</u> | 8 |                               |

| Sieve Size               | Design No. | Combined Bin Analysis |       |              |       |       |       |       |       | Extractions |       |       |  |
|--------------------------|------------|-----------------------|-------|--------------|-------|-------|-------|-------|-------|-------------|-------|-------|--|
|                          |            | 1                     | 2     | Design No. 2 | 4     | 5     | 6     | 7     | 8     | 1           | 2     | 3     |  |
| <del>1 1/2" - 3/4"</del> |            |                       |       |              |       |       |       |       |       |             |       |       |  |
| <del>3/4" - 1/2"</del>   |            |                       |       |              |       |       |       |       |       |             |       |       |  |
| <del>1/2" - 3/8"</del>   |            |                       |       |              |       |       |       |       |       |             |       |       |  |
| 1/2" - 3/8"              |            | 1.3                   | 1.1   | 0.9          | 1.3   | 0.8   | 1.7   | 2.0   | 1.5   |             | 0.8   | 1.2   |  |
| 3/8" - 4"                |            | 36.9                  | 37.2  | 38.0         | 36.9  | 35.8  | 36.5  | 36.2  | 36.7  |             | 36.9  | 35.6  |  |
| <del>4" - 10"</del>      |            |                       |       |              |       |       |       |       |       |             |       |       |  |
| 4" - 10"                 |            | 22.3                  | 22.5  | 21.8         | 22.3  | 23.2  | 22.6  | 22.5  | 22.8  |             | 22.4  | 23.5  |  |
| + 10"                    |            | 60.5                  | 60.8  | 60.7         | 60.5  | 59.8  | 60.8  | 60.7  | 61.0  |             | 60.1  | 60.3  |  |
| 10-40"                   |            | 13.0                  | 13.9  | 14.1         | 13.2  | 13.7  | 13.5  | 13.6  | 13.2  |             | 14.3  | 13.3  |  |
| 40-80"                   |            | 10.1                  | 10.0  | 9.5          | 10.2  | 11.2  | 10.5  | 10.1  | 10.3  |             | 9.6   | 10.6  |  |
| 80-200"                  |            | 6.4                   | 5.8   | 6.0          | 6.5   | 6.1   | 6.1   | 6.0   | 6.3   |             | 5.8   | 6.2   |  |
| Pass 200"                |            | 3.2                   | 2.7   | 2.9          | 3.2   | 2.8   | 2.7   | 3.2   | 2.8   |             | 3.6   | 3.3   |  |
| Asphalt                  |            | 6.8                   | 6.8   | 6.8          | 6.4   | 6.4   | 6.4   | 6.4   | 6.4   |             | 6.6   | 6.3   |  |
| Total                    |            | 100.0                 | 100.0 | 100.0        | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |             | 100.0 | 100.0 |  |

| Bin Anly. No. | Extr. No. | Time  | Loca. No. | Course of Courses | Station No. | Mix Plant | Temp. °F. Road | Specimen Nos. | Lab Dens. | % Stab. |
|---------------|-----------|-------|-----------|-------------------|-------------|-----------|----------------|---------------|-----------|---------|
| 1             |           | 7:40  | 1         | 1                 | 2           | 50+37     | 275            | 265           |           |         |
| 2             |           | 8:45  | 1         | 1                 | 2           | 70+84     | 270            | 255           |           |         |
| 4             | 1         | 9:40  | 1         | 1                 | 2           | 80+55     | 255            | 260           | 10-1,2,3  | 98.0 38 |
| 5             |           | 10:30 | 1         | 1                 | 2           | 91+10     | 270            | 260           | 11-1,2,3  | 96.9    |
| 6             |           | 11:30 | 7         | 1                 | 1           | 104+22    | 275            | 260           |           |         |
| 6             |           | 2:00  | 2         | 1                 | 1           | 87+65     | 275            | 265           |           |         |
| 7             | 2         | 3:45  | 2         | 1                 | 1           | 79+10     | 260            | 260           | 12-1,2,3  | 97.1 44 |
| 7             |           | 4:30  | 2         | 1                 | 1           | 69+40     | 270            | 260           |           |         |

| Materials Used  |                |                  |
|-----------------|----------------|------------------|
|                 | Asphalt (Tons) | Aggregate (Tons) |
| Previous Report | 122.3          | 1688.9           |
| This Report     | 44.5           | 622.0            |
| Total To Date   | 166.8          | 2310.9           |

| Percent Complete—Asphaltic Concrete Pavement |  |      |
|--|--|------|
| Percent Complete—This Type                   |  | 16 % |
| Percent Complete—All Types                   |  | 79 % |

| Days Run     |                   |         |    |         |              | Rate of Application |      |            |      |          |      |
|--------------|-------------------|---------|----|---------|--------------|---------------------|------|------------|------|----------|------|
| Location No. | Course of Courses | Station | to | Station | Width (Feet) | 125 inches          |      | 100 inches |      | Inches   |      |
|              |                   |         |    |         |              | Sq. Yds.            | Tons | Sq. Yds.   | Tons | Sq. Yds. | Tons |
| 1            | 1                 | 2       |    | 50+37   | 102+39       | 12                  | 6936 | 436.0      |      |          |      |
| 7            | 1                 | 2       |    | 102+39  | 110+58       | 12                  | 1092 | 68.6       |      |          |      |
| 6            | 1                 | 1       |    | 110+50  | 113+20       | 12                  |      |            | 360  | 18.2     |      |
| 2            | 1                 | 1       |    | 89+32   | 63+76        | 10                  |      |            | 2840 | 143.7    |      |

|  |                   |       |             |       |             |
|--|-------------------|-------|-------------|-------|-------------|
| Weather <u>Partly cloudy and hot.</u>                            | Total Today       | 8028  | 504.6       | 3200  | 161.9       |
| Min. Temp. <u>83</u> °F.   | Previous Report   | 29233 | 1811.2      | 0     | 0.0         |
| Max. Temp. <u>99</u> °F.   | Total To Date     | 37261 | 2315.8      | 3200  | 161.9       |
| Remarks <u>Laydown machine broke down from 2:15 to 3:45 p.m.</u> | Avg. Rate To Date | 124.3 | Lbs/Sq. Yd. | 101.2 | Lbs/Sq. Yd. |

Location No. 1 on Control 5-6-7. Location No. 7 on Control 5-7-9

*John Lee*  
Inspector

Type D Date 9-2-64 Report No. 1



roads by "N. B." for north-bound, "E. B." for east-bound, etc., and by the lane of lanes numbers. If two-way frontage roads are encountered, omit the direction of traffic movement for these frontage roads and identify them by their direction from the centerline of the facility (North, South, etc.) and by the lane of lanes numbers. Number the mainlanes from the centerline of the facility toward the right-of-way line beginning with the number "one." Number all frontage road lanes from the lane nearest to the mainlanes toward the right-of-way line beginning with the number "one." The direction of the traffic movement together with the beginning Station No. as shown in the example will adequately identify all Deceleration Lanes, Acceleration Lanes, Entrance Ramps, and Exit Ramps. The two spaces left blank are for use when paving sections not described, such as detours and shoulders, and when paving on two control-sections during the same day. When paving on two control-sections during the same day, enter the location identification of the first control-section in the appropriate space provided and enter the location identification of the second control-section in one of the blank spaces. The corresponding "location numbers" for each should then be used in the section for road data under the "Combined Bin Analysis" section and in the section "Days Run" and footnote the two Location Nos. under "Remarks" as shown in the example. It is recommended that a sketch showing the numbering of the various lanes and sections and the course information for the various sections be prepared and a copy submitted with the first report along with the required Density-Stability Curve.

Under the heading, "Combined Bin Analysis," under the column, "Sieve Size," fill in any sieve size not listed that is required by the governing specification and strike out any sieve size that is listed on the form but not required by the specification. Under the column, "Design No.\_\_\_\_," show the sieve analysis that was developed by laboratory tests in accordance with Bulletin C-14. For example, on Page 19 of this Bulletin, on Construction Form No. 544 Rev.(2) under "Combined Analysis," the actual grading that was obtained from the bin analysis prior to starting paving operations is shown. This analysis is used as Design No. 1 in the example. Under the columns, "1, 2, 3," etc., show the actual combined bin analysis made on the job, in accordance with Bulletin C-14. These tests are made throughout the day and should check within the tolerances outlined in the specifications. After the plant operations have been adjusted and the hot-bins have been balanced, it probably will be necessary to make minor revisions in the sieve analysis under the column, "Design No.\_\_\_\_." Due to slight variations in aggregate gradations, several revisions may be necessary during the life of a project. It is recommended that the amount of plus 10 mesh sieve material not be lowered below the laboratory design. After each revision is made in the sieve analysis or the asphalt content, a new design number is to be used as shown in the example on Page No. 42. Designs should be numbered consecutively.

Extraction samples are to be taken as specified in the last paragraph on Page 30. When an extraction sample is taken, assume in this case under "Extractions, Column 1," then enter the same number in the section below under the column, "Extr. No.," and record the time the sample was taken, the Location No., the course of courses numbers, the station number from where the sample was taken, the temperature of the mixture at the road when the sample was taken, the laboratory specimen identification numbers, the density of the laboratory specimens, and the stability as reported by the Austin Laboratory. This will provide the pertinent information regarding the particular extraction sample.

In order to provide additional and better control of the mix, the extraction test is to be completely divorced from any combined bin analysis. This is the rea-

son that it is preferable for the extraction sample to be taken from the roadway. It is recommended that no extraction sample be taken within 30 minutes of the time of the taking of any combined bin analysis sample.

So that there will be no misunderstanding concerning the "Course of Courses" data that is to be recorded on this form, a course of asphaltic concrete pavement is defined as the application made by a single pass of the finishing machine. Courses are to be numbered from the bottom to the top, beginning with the number "one" for each type of asphaltic concrete mix.

If the material is being paid for separately as Aggregate and Asphalt, separate the day's tonnage and show in the section headed "Materials Used." The design percent of asphalt will be used for both weigh-batch and continuous-mix plants in determining the pay quantity of asphalt. When using a continuous-mix plant, it may not be possible to obtain the exact design percent of asphalt in the mixture, in which case the percent of asphalt being used, as determined in calibrating the plant will be used for the design percent of asphalt and in calculating the pay quantity of asphalt.

Under the heading, "Percent Complete-Asphaltic Concrete Pavement," the "Percent Complete-This Type" is the percent of the number of tons shown in the contract for the type of asphaltic concrete being placed that has been placed through the date of the report. The "Percent Complete-All Types" is the percent of the total number of tons shown in the contract for all types of asphaltic concrete to be placed that has been placed through the date of the report.

Under the heading, "Days Run," give the Location No., course of courses numbers, station to station, width, and under each rate of application applied during the day give the square yards and tons of material placed, the totals and the average rate to date.

Give data regarding weather, and the minimum and maximum temperature.

On the back of the first report, list the source of all aggregates, showing the location of the pit or producer. Show the approximate size of the aggregate and also its average bulk specific gravity. List the type of asphalt used, the producer, and its specific gravity. Unless the sources of material properties change, it will not be necessary to furnish this information with subsequent reports.

Please note that there is no place for "Tack Coat" on Construction Form No. 404 Rev.(2). Please show the tack coat used on Form 187, "Daily Road Report-Asphalt." Under "Remarks" place the words, "Tack Coat."

Make four copies of Construction Form No. 404 Rev.(2) on Federal Projects, two for File D-6, one for the District Engineer, and one for the Resident Engineer. Make three copies of State Projects, one for File D-6, one for the District Engineer and one for the Resident Engineer, to be prepared daily and submitted at least once each week.

In the event the contract calls for rock asphalt, cut-back asphaltic concrete, or hot-mix cold-laid asphaltic concrete which is generally mixed at some central mixing point and shipped ready for use, or if hot-mix asphaltic concrete is being furnished from a plant where D-9 performs the inspection, it will not be necessary to show the design or control tests. Show the Laboratory report numbers covering inspection of the material used each day.

## EQUIPMENT

The laboratory equipment necessary for the proper design and control of an asphaltic concrete paving mixture is listed below. The equipment and supplies fall into two categories:

1. Material that is to be secured locally.
2. Equipment that is to be obtained from the Equipment and Procurement Division by requisition. In requisitioning material from the Equipment Division, please itemize each item in a manner similar to that shown below. This will greatly facilitate the handling of your requisition.

### Material to be Secured Locally

- 4 - 1/2-gal. Mason Fruit Jars
- 1 - Siphon Bulb (Ear Syringe)
- 1 - 3-gal. Bucket
- 25 lbs. Paraffin (If Used)
  - \* Supply of Carbon Tetrachloride, Benzol, or 1,1,1-Trichloroethane
  - Supply of Butane or Propane Gas

### Equipment to be Obtained from Equipment and Procurement Division

- 1 - Laboratory Press, complete with Molding Assembly
- 1 - Large Electric Extractor, or
- 1 - Large Hand Extractor
- 1 - Hand Sieve Shaker, or 1 - Electric Sieve Shaker
- 1 - Torsion Balance
- 1 - Set of Weights
- 1 - Triple Beam Balance
- 2 - Gas Hot Plates
- 1 - Oven
- 1 - Desiccator
- 6 - 3-qt. Milk Pans
- 6 - 2-qt. Milk Pans
- 6 - 4-inch Pointing Trowels
- 2 - Pycnometer Tops
- 1 - Set Sieves (See Specifications to determine Sieve Sizes necessary)
  - 1 - Sieve Top
  - 1 - Sieve Bottom
  - 1 - Balance Hook
  - Supply of 4-inch Paper Gaskets
  - Supply of Extractor Filter Rings (Use each filter ring as long as possible; a dozen filter rings will take care of a very large project, if properly cared for.)
- 2 - Thermometers, 0-200° F.
- \*\* 2 - Thermometers, Asphalt
- \*\* 2 - Thermometers, Quick Reading - Dial Face

\*Carbon Tetrachloride not recommended due to being a health hazard. Benzol not recommended due to being a fire hazard. 1,1,1-Trichloroethane recommended by Administrative Circular No. 84-63.

- 1 - 2000 ml. Graduate
- 1 - 100 ml. Pipette
- 1 - 100 ml. Volumetric Flask
- 2 - 200 ml. Silica Evaporating Dishes
- \*\*\*1 - Brass Still
- \*\*\*2 - Moisture Traps of 25 ml. Capacity equipped with Cork Stoppers
- \*\*\*2 - Volatile Traps of 12.5 ml. Capacity equipped with Cork Stoppers
- \*\*\*2 - Water Cooled Liebig Condensers
- \*\*\*2 - Ring Stands
- \*\*\*2 - Clamps
- \*\*\*2 - Rings

\*\*\*For Cold Mix Asphaltic Concrete Plants Only.