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A STUDY OF THE DECANTATION TEST ON NORMAL SAMPLES AND SIEVE ANALYSIS SAMPLES

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PREFACE

This study is a comparison of decantation test results on coarse aggregate. The comparisons are made on samples tested in accordance with Test Method Tex-406-A, "Materials Finer Than No. 200 Sieve in Mineral Aggregates," (Decantation Test for Concrete Aggregates) and sieve analysis samples that have been sieved, recombined and then tested in accordance with Test Method Tex-406-A. The comparisons were made on ten different classifications of coarse aggregates from the harder silicious gravels to the softer materials such as crushed limestone.

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I. SUBJECT

Decantation is used to determine the amount of material finer than a No. 200 sieve which coats or clings to an aggregate and is lost after soaking in water and washing over the sieve. Aggregate particles, silt and clay that are dispersed by the wash water as well as water-soluble materials will be removed from the aggregate during the test.

II. PURPOSE

The purpose of this study is to show the comparison of decantation test results based on two types of sample preparation and handling. Normal procedure is to weigh out different samples for the sieve analysis test and the decantation test. This procedure seemed to present duplication of work, require additional material and, in some cases when samples received from the field were small, time and freight were lost in requiring the sampling and shipping of additional material. It was hoped that this work would show that duplicate samples would not be necessary.

III. TEST PROCEDURES

Samples for decantation and sieve analysis were prepared according to Test Method Tex-406-A, "Materials Finer Than No. 200 Sieve in Mineral Aggregates," (Decantation Test for Concrete Aggregates) and Test Method Tex-401-A, "Sieve Analysis of Fine and Coarse Aggregate," respectively. Copies of these are included in the Appendix. One sample was tested in accordance with Test Method Tex-401-A. After completing this test the sample was recombined and tested in accordance with Test Method Tex-406-A.

The other sample was tested in accordance with Test Method Tex-406-A only. The results of these two tests were compared. The test procedures are given in Appendices I and II.

IV. CONCLUSIONS

1. The variation in the decantation results are primarily due to manipulation of the aggregate during the sieve analysis test.

2. The aggregates that were harder, such as silicious or rhyolite gravel, did not break down during the sieve analysis operation. The softer aggregates, such as crushed limestone, had a tendency to produce more fines during the sieving operation. This produced a higher decantation loss and if the sieve analysis sample had been used for decantation, three samples would have failed the maximum decantation loss of 1.0 percent. It was noted that although several of the limestones showed considerable increase in decantation when comparing results, only three of twenty-three or thirteen (13) percent would have failed these conditions. All three of these samples are from the same source.

3. Of all the other nine categories of samples, none of the sieve analyses samples came close to failing the decantation test when compared to the regular decantation sample.

V. RECOMMENDATIONS

It is recommended that only one sample be weighed out for the sieve analysis and decantation tests. The sieve analysis (Test Method Tex-

401-A) shall be performed first, then the sample recombined including the minus No. 4 material, and the decantation test (Test Method Tex-406-A) performed. The exception to this procedure will be crushed limestone aggregates where both a sieve analysis and decantation sample will be weighed out of the material received for testing. The sieve analysis on these samples will be performed first, recombined and tested for decantation. Should this sample fail the specifications, the second or regular decantation sample will then be run and its results only will be reported.

No changes to either Test Method Tex-401-A or Tex-406-A are recommended except that a note should be added at the end of Part I, Laboratory Method, Test Method Tex-406-A as follows:

> If desired, the decantation test may be performed on the recombined sample used in performing the sieve analysis (Test Method Tex-401-A) provided that no material is lost. It may be preferable to run the decantation test on soft crushed limestones using separate samples since some fines may be produced during the sieve analysis test due to degradation of the soft edges of the aggregates.

VI. DISCUSSION

From time to time the Materials and Tests Division has found that aggregate samples from the field did not contain quite enough material to perform each test required. Many times this required a call to the Engineer for additional material even though a few pounds or grams of

certain sizes would have been sufficient. This has been the cause of some delays in the field forces obtaining test results and in additional expense in resampling and shipping.

It was felt that material used for the sieve analysis test or the decantation test would many times be sufficient if it could be possible to use the same material for these tests. The reasoning behind this work was that it would assist the field forces to obtain results quicker and more economically in some cases.

The following table gives the ten classifications into which the aggregates were typed for this work. The number of each type tested is also given.

Table I

Classification of Aggregates	Number of Samples Compared
Silicious Gravel	2
Crushed Silicious Gravel	1
Partially Crushed Silicious Gravel	10
Limestone Gravel	4
Crushed Limestone	23
Partially Crushed Limestone Gravel	3
Limestone and Silicious Gravel	8
Partially Crushed Limestone and Silicious Gravel	6
Crushed Dolomitic Limestone	6
Partially Crushed Rhyolite Gravel	9
Total	72

Table II gives a tabulation of the samples tested by types or classifications and the decantation losses when tested according to Test Method Tex-406-A. The last column gives the decantation loss when a normal sample was used for the sieve analysis test, Test Method Tex-401-A. After sieving and weighing, all the material was recombined and the decantation test performed on the total sample.

The results of this work show very close correlation between the two test procedures. There are undoubtedly some differences due to variations in both material and sampling. In some few cases it was originally thought that dust collection equipment used in Test Method Tex-401-A may have pulled off some fines whereas the dust equipment was not used in Tex-406-A. This was ruled out as a significant factor since many tests are quite close both ways or else the loss by Test Method Tex-401-A, sieve analysis samples, is greater.

Of the seventy-two materials tested only three failed by having 1.0 percent or more loss. These three failed the sieve analysis decantation but did pass the regular decantation test although two of the three were fairly high at 0.76 and 0.89 percent loss. All three of these samples are reasonably soft limestones from the same source. It was postulated that softer crushed limestones were more prone to wearing off edges of particles during sieving and thus produced more dust due to this operation. Decantation tests on such samples probably should be run with care and checked with regular decantation samples should they fail the sieve analysis decantation as done herein.

Table II

Material	Percent Decantation Loss On Regular Sample Test Method Tex-406-A	Percent Decantation Loss On Sieve Analysis Sample Test Method Tex-401-A
Silicious Gravel	0.56	0.31
	0.26	0.26
Crushed Silicious Gravel	0.41	0.32
Partially Crushed Silicious Gravel	0.26	0.19
	0.16	0.26
	0.33	0.22
	0.15	0.28
	0.33	0.12
	0.13	0.05
	0.27	0.49
	0.28	0.14
	0.25	0.43
	0.20	0.49
Limestone Gravel	0.38	0.46
	0.32	0.53
	0.08	0.10
	0.42	0.33
Partially Crushed Limestone Gravel	0.10	0.10
	0.10	0.33
	0.35	0.54

Table II - Continued

Material	Percent Decantation Loss On Regular Sample Test Method Tex-406-A	Percent Decantation Loss On Sieve Analysis Sample Test Method Tex-401-A
Limestone & Silicious Gravel	0.53	0.66
	0.34	0.36
	0.42	0.46
	0.43	0.46
	0.50	0.48
	0.37	0.30
	0.18	0.13
	0.10	0.10
Partially Crushed Limestone & Silicious Gravel	0.51	0.49
	0.39	0.44
	0.08	0.03
	0.24	0.25
	0.18	0.20
	0.17	0.32
Crushed Dolomitic Limestone	0.52	0.38
	0.28	0.30
	0.26	0.19
	0.21	0.37
	0.26	0.46
	0.07	0.33

Table II - Continued

Material	Percent Decantation Loss On Regular Sample Test Method Tex-406-A	Percent Decantation Loss On Sieve Analysis Sample Test Method Tex-401-A
Partially Crushed Rhyolite Gravel	0.31	0.40
	0.31	0.37
	0.36	0.36
	0.36	0.51
	0.56	0.69
	0.40	0.27
	0.23	0.39
	0.25	0.18
	0.19	0.16
Crushed Limestone	0.25	0.20
	0.37	0.46
	0.82	0.74
	0.76	1.44*
	0.13	0.21
	0.61	0.28
	0.14	0.17
	0.31	0.56
	0.49	0.36
	0.29	0.27
	0.37	0.46
	0.33	0.37

Table II - Continued

Material	Percent Decantation Loss On Regular Sample Test Method Tex-406-A	Percent Decantation Loss On Sieve Analysis Sample Test Method Tex-401-A
Crushed Limestone - Continued	0.13	0.13
	0.47	0.51
	0.09	0.09
	0.59	0.87
	0.40	1.22*
	0.18	0.62
	0.82	0.93
	0.54	0.83
	0.77	0.78
	0.12	0.18
	0.89	1.34*

* These three samples would have failed the maximum decantation loss of 1.0 percent. All three samples were from the same source.

APPENDIX I

Texas Highway Department

Materials and Tests Division

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE

Scope

This test method, which is a modification of A.S.T.M. Designation: C 136, covers a procedure for the determination of the particle distribution of fine and coarse aggregate samples using sieves with square openings. The test is intended for use in the analysis of aggregates for portland cement concrete and surface treatments. It is also applicable to the sieve analysis of mineral fillers.

Definitions

The term "sieve" as used in this procedure is intended to denote wire mesh with square openings meeting the requirements of A.S.T.M. Designation E 11 and used for the separation of aggregates into various specified sizes.

Apparatus

1. Sample splitter or quartering cloth.
2. Set of Standard U. S. Sieves (A. S. T. M. E 11 Specifications)
3. Mechanical sieve shaker.
4. Balance or scale of at least 4500 grams capacity, sensitive to 0.1 gram, accurate to 0.5 gram, meeting requirements of Test Method Tex-901-K Class III-D balance or Class IV-A scales.
5. Drying oven maintained at 230 $\pm$ 9F.
6. Graniteware pans with diameter to fit sieves.
7. Small scoop, brushes, etc.

Test Record Form

Identify the material with laboratory number and record test data on Work Sheet Form D9-A-3 or Field Laboratory Aggregate Sieve Analysis Report Form No. 310.

Preparation of Sample

Select a representative portion of processed aggregates submitted from stockpiles or plant bins. In the case of stone or gravel obtained from a pit site, which will be processed in a crushing and screening plant curing construction, crush the material to the maximum size permitted by specifications. For materials consisting of a mixture of fine and coarse aggregate, use a No. 4 sieve and separate into two sizes before obtaining test sample.

Prepare the aggregate as follows:

A. Coarse Aggregate

1. The sample of aggregate to be tested for sieve analysis shall be thoroughly mixed and reduced by use of a sample splitter or by quartering to an amount that will be approximately 4000 grams when dried.

2. Place the approximate 4000 gram sample of aggregate in an oven and dry to substantially constant weight at a temperature of 230°F $\pm$ 9°. Remove the sample from the oven and allow to cool to room temperature. Coarse aggregate need not be dry for tests in the field.

B. Fine Aggregate, Laboratory Method

1. Select a representative sample of approximately 2000 grams from material that has been thoroughly mixed and that contains sufficient moisture (about SSD condition) to prevent segregation. Where the fine aggregate is a combination of sands, the sample shall contain these sands in the proportions by weight in which they will be used. Do not include mineral filler in the sieve analysis.

2. Determine the amount of material finer than the No.200 sieve in accordance with Part I of Test Method Tex-406-A.

3. Reduce dry sample (from Step #6 of Part I of Tex-406-A) to approximately 1000 grams by means of a splitter or quartering cloth.

4. Weigh the sample to the nearest estimated 0.1 gram.

Note: In no case shall the fraction retained on any sieve at the completion of the sieving operation weigh more than 4 g/in.^{2} of sieving surface.

C. Fine Aggregate, Field Method

1. Secure a representative sample of approximately 2000 grams of the sand to be tested. Where the fine aggregate is a combination of sands, the sample shall contain these sands in the proportions by weight in which they occur in the total weight of sand used in the mix. Do not include mineral filler in the sieve analysis.

2. Dry the sample to below saturated surface-dry in the sun or by artificial heat.

3. Weigh out a sample of the sand of exactly 1000 grams.

D. Mineral Filler

Dry the mineral filler at a temperature not to exceed 230°F. and then obtain a laboratory test size sample of approximately 500 grams by carefully quartering the material. Perform the sieve analysis immediately after removing from oven.

Procedure

1. Perform the sieve analysis on the aggregate sample by separating the material into a series of particle sizes by means of such sieves as are necessary to determine compliance with specifications for the material. Place the set of sieves, with largest openings on top, into a pan and pour the prepared aggregate onto the top screen. The hand sieving is done by means of a lateral and vertical motion of the sieves accompanied by a jarring action so as to keep the material moving continuously over the surface of the sieves. Limit the amount of material on each sieve to a single layer to prevent clogging the openings and continue sieving until not more than one percent of the residue passes any sieve in one minute of shaking. Do not turn or manipulate particles through the openings of the sieves by hand. If mechanical sieving is used, shake the material for approximately ten minutes and check the thoroughness of sieving by the hand method described above.

2. Determine the weight to the nearest estimated 0.1 gram of particles retained on each sieve using a scale with a capacity large enough to obtain the weight of the total sample. Weigh the portion of aggregate retained on the largest size sieve first, record this weight, then place the contents of the next largest size sieve on the scale and obtain the cumulative weight of the two sizes. Continue this operation of obtaining cumulative weights until the contents of the smallest sieve used has been emptied and weighed.

Calculations

Use the cumulative weights to calculate the percentages retained on the various sieves on the basis of the dry weight of the total sample which includes the weight of the material which passed the smallest size sieve used in the analysis as follows:

$$\text{Percent retained} = \frac{\text{Weight retained (grams)}}{\text{Weight of total sample}} \times 100$$

Note: Add the percentage finer than No. 200 sieve determined by Tex-406-A to the percentage passing No. 200 sieve by dry sieving of the same sample. Total sample weight for calculating percentages retained will be the dry weight of the sample plus the proportionate weight loss by washing (Tex-406-A).

Reporting Test Results

Report the percentages to the nearest whole number for the total percentages retained on each sieve used on Form No. 272.

Notes

In performing this analysis use precaution to lose none of the sample during the shaking or weighing operations. However, if there is an insignificant discrepancy between the original dry weight of the sample and the sum of the weights of the various parts, assume the small amount of particles passing the smallest size sieve and use the original weight.

APPENDIX II

Texas Highway Department

Materials and Tests Division

MATERIALS FINER THAN NO. 200 SIEVE IN MINERAL AGGREGATES

(DECANTATION TEST FOR CONCRETE AGGREGATES)

Scope

This method describes procedures for determining the amount of material finer than a No. 200 sieve in aggregate by washing. Aggregate particles, silt and clay particles that are dispersed by the wash water as well as water-soluble materials will be removed from the aggregate during the test.

PART I
LABORATORY METHOD
(ASTM Designation: C 117)

Apparatus

1. Balance or scale of at least 4500 grams capacity, sensitive to 0.1 gram, accurate to 0.5 gram, meeting requirements of Test Method Tex-901-K Class III-D balance or Class IV-A scales.
2. Drying oven maintained at 230° ± 9°F.
3. Graniteware milk pan 12 inches in diameter and 5 inches deep
4. Sieve - a standard U. S. No. 200 sieve
5. Sample splitter or quartering cloth

Test Record Forms

Record test data on Form D9-A-3 and report results on Form No. 272 or Field Laboratory Aggregate Sieve Analysis Report Form No. 310.

Procedure

Where a sample contains both fine and coarse aggregates and the specification requirements are written separately on these aggregate fractions, the sample shall be sieved prior to test into the coarse and fine aggregate portions as defined by the specifications.

1. The sample of the aggregate to be tested shall be thoroughly mixed and reduced by use of a sample splitter or quartering cloth to an amount suitable for testing. The aggregate shall be moistened before reduction to minimize segregation and loss of dust, and the sample for test shall be the end result of the reduction method. Reduction to an exact predetermined weight is not recommended. The weight of the test sample, after drying, shall conform with the following:

Nominal Maximum Size	Minimum Weight, Grams
1-1/2 in. or larger	5000
3/4 in.	2500
3/8 in.	2000
No. 4	2000

2. Dry the aggregate to constant weight at a temperature of 230° ± 9°F. and obtain the dry weight of the sample to the nearest estimated 0.1 gram.

3. (a) When specifications limit the amount of deleterious materials (which are defined in various specifications as clay lumps, shale, soft or laminated particles, vegetable matter, or other objectionable material) separate, classify and determine the amount of each type of deleterious material in accordance with Test Method Tex-413-A.

(b) Weigh the remaining sample to the nearest estimated 0.1 gram.

4. Place the remainder of the aggregate into a graniteware pan, cover with tap water and allow to soak for 24 hours.

5. After the aggregate has been thoroughly saturated, use the hands to vigorously agitate the material and then decant the wash water over the No. 200 sieve. Add water and repeat washing and decanting until the wash water is clear. Recover any of the aggregate that spilled onto and is retained on the No. 200 sieve.

6. Dry the washed material to constant weight in an oven, weigh and record the net weight of the washed aggregate.

Calculations

Calculate the percentage of material finer than the No. 200 sieve or loss from the following expression:

$$\text{Percent loss} = \frac{W_1 - W_2}{W_1} \times 100$$

Where:

W_1 = Original dry weight of aggregate or weight of sample remaining from 3 above

W_2 = Dry weight of aggregate after washing

PART II
FIELD METHOD FOR CONCRETE AGGREGATES

Apparatus

1. Balance or scale of at least 4500 grams capacity, sensitive to 0.1 gram, accurate to 0.5 gram, meeting requirements of Test Method Tex-901-K Class III-D balance or Class IV-A scales.

2. Wide-mouth funnel
3. Calibrated pycnometer, Figure 1, Test Method Tex-403-A
4. Sieve-Standard U. S. No. 200 sieve. (Required in laboratory, optional in field)
5. A watch or clock with second hand
6. Sample splitter or large pan
7. Towel or lint-free cotton cloth

Test Record Forms

Record test data on Work Sheet Form D 9-A-3 and report test data on Form 272.

Procedure

1. Thoroughly mix the representative sample and secure a portion weighing approximately 1200 grams. The sample need not be weighed and the moisture content of the material is not considered since these factors have no bearing upon the test values.

Note: When specifications limit the amount of deleterious materials (which are defined in various specifications as clay lumps, shale, soft or laminated particles, vegetable matter, or other objectionable material) the sample shall be dried to a constant weight at a temperature of 230° ± 9°F. Separate, classify and determine the amount of each type of deleterious material in accordance with Test Method Tex-413-A. The remaining sample is transferred to the pycnometer for the decantation test.

2. Place the sample into the half-gallon pycnometer jar and cover with water.

(a) If the material is no drier than saturated, surface-dry, proceed immediately to Step 3 below.

(b) If the moist condition of the material is in doubt, or if the material is drier than saturated, surface-dry, allow to stand undisturbed for at least 24 hours.

3. Then fill the jar with water to within 1/2 inch of the rim, screw the pycnometer cap on the jar until the match marks coincide and then fill completely with water. Stop the hole in the cap with finger and roll the pycnometer to free the entrapped air. Raise and lower the jar in such a manner that the material will flow back and forth in the jar while it is being rolled. Set the pycnometer on work bench and refill the cap to remove any air bubbles. Take precautions to prevent loss of fine material while removing the entrapped air. Use the towel to dry the outside of the pycnometer, fill level full with water and weigh. Record the weight to the nearest estimated 0.1 gram as Z_1.

4. When testing sand, close the opening in the cap with the finger or thumb and agitate the contents of the pycnometer by rolling the pycnometer with a swinging motion. When testing coarse aggregate, the pycnometer should be rolled gently in order to avoid breaking the jar. Place the jar in an upright position and allow the very fine particles to settle for 15 seconds. Remove the cap from the jar and slowly pour out the liquid, taking care to lose none of the fine material. Only the material in suspension should be decanted. Repeat the above operation until the water above the fine aggregate is reasonably clear after a 15 second settling period.

Note: As a precaution against loss of material, it is recommended that the water be decanted into a No. 200 sieve.

5. Recover any material which may be retained on the No. 200 and return to the pycnometer. Screw the pycnometer cap on the jar and fill with water. Dry the outside of the pycnometer and complete filling the cap level with water. Weigh and record the weight as Z_2.

Calculations

Calculate the percent loss by decantation as follows:

$$\text{Percent loss} = \frac{Z_1 - Z_2}{Z_1 - Y} \times 100$$

Where:

Z_1 = weight of pycnometer containing sample and water to fill, before washing

Z_2 = weight of pycnometer containing sample and water to fill, after washing

Y = weight of the pycnometer filled with water at approximately the same temperature at which Z_1 and Z_2 were determined

Notes

The percentage by weight of material lost by decantation is equal to the percentage by absolute volume, assuming that the specific gravity of the material lost to be the same as that of the particles remaining.

Figure 1

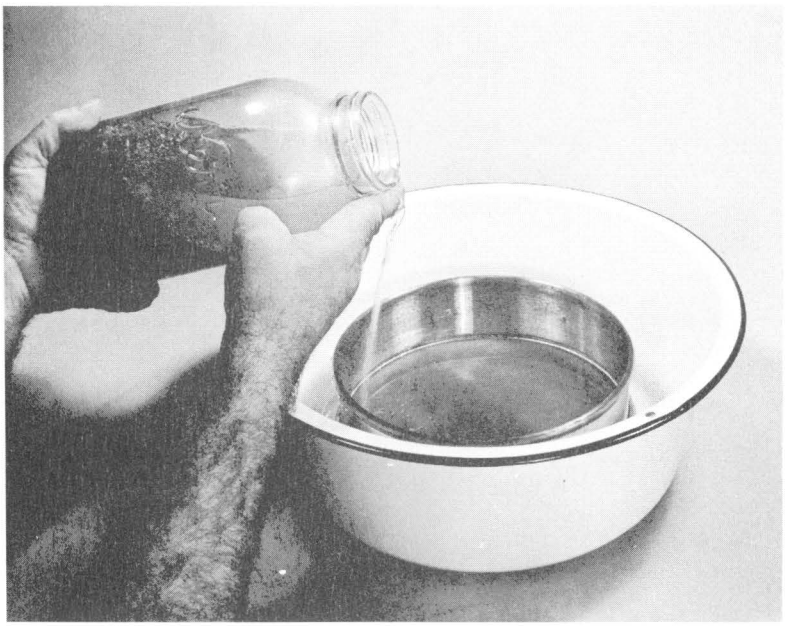

Figure 2