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16. Abstract

During the course of Research Study 2-9-80-285 "Asphalt Concrete Mixture Design and Specification," it was desired to address two questions concerning sieve analysis of hot-mix asphaltic concrete aggregates which are often raised by personnel of the Texas State Department of Highways and Public Transportation (SDHPT). These questions are as follows:

1. Would the use of wet sieving (with its associated additional effort) to replace or supplement dry sieving be justified, based on the additional knowledge gained and problems alleviated, for the design and production monitoring of hot mixes?
2. Would the use of concrete sieves in place of hot-mix sieves for hot-mix design and production monitoring be justified based on the additional knowledge gained and the unified use of the same sieve sizes for both concrete and hot-mix testing?

In an effort to answer these questions, a minimum of 10 dry, wet and extraction sieve analyses were accomplished on 10 different produced hot-mixes for the SDHPT during the summer of 1982. In all, four hot-mixes were sampled from four weigh-batch plants, and six were sampled from four drum-dryer plants. The predominant type of hot-mix sampled was SDHPT Item 340 Type "D". Most of the aggre-combinations had limestone coarse aggregates and siliceous field sand fine aggregates, although one mixture consisted entirely of crushed gravel and another entirely of pit run iron ore.

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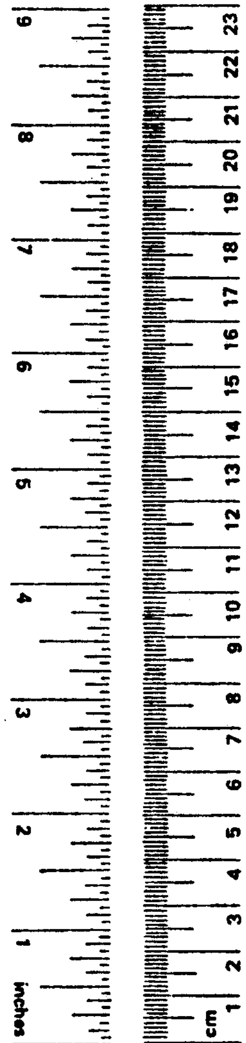
Results of this study indicated (1) that there was no general need to adopt wet sieving, and (2) that concrete sieves did not offer enough extra information and economy of standardization to merit adopting their usage in place of hot-mix sieves. The results of this study and the experience of one district did, however, indicate that there may be occasions where wet sieving during the design process may be very useful in precluding a mix design that may generate excessive minus No. 200 material, thus causing trouble with staying within grading limits and design tolerances.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

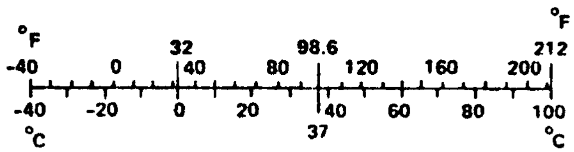
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



EVALUATION OF AGGREGATE
SIEVING METHODS FOR HOT-MIX
ASPHALTIC CONCRETE DESIGN AND PRODUCTION

by

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Research Report 285-2
Research Study Number 2-9-80-285
Asphalt Concrete Mixture Design and Specification

Sponsored by

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The Texas A&M University System
College Station, Texas

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EXECUTIVE SUMMARY

During the course of Research Study 2-9-80-285 "Asphalt Concrete Mixture Design and Specification," it was desired to address two questions concerning sieve analysis of hot-mix asphaltic concrete aggregates which are often raised by personnel of the Texas State Department of Highways and Public Transportation (SDHPT). These questions are as follows:

1. Would the use of wet sieving (with its associated additional effort) to replace or supplement dry sieving be justified, based on the additional knowledge gained and problems alleviated, for the design and production monitoring of hot-mixes?

2. Would the use of concrete sieves in place of hot-mix sieves for hot-mix design and production monitoring be justified based on the additional knowledge gained and the unified use of the same sieve sizes for both concrete and hot-mix testing?

In an effort to answer these questions, a minimum of 10 dry, wet and extraction sieve analyses were accomplished on 10 different produced hot-mixes for the SDHPT during the summer of 1982. In all, four hot-mixes were sampled from four weigh-batch plants, and six were sampled from four drum-dryer plants. The predominant type of hot-mix sampled was SDHPT Item 340 Type "D". Most of the aggregate combinations had limestone coarse aggregates and siliceous field sand fine aggregates, although one mixture consisted entirely of crushed gravel and another entirely of pit run iron ore.

Results of this study indicated (1) that there was no general need to adopt wet sieving, and (2) that concrete sieves did not offer enough extra information and economy of standardization to merit adopting their usage in place of hot-mix sieves. The results of this study and the experience of one district did, however, indicate that there may be occasions where wet sieving during the design process may be very useful in precluding a mix design that may generate excessive minus No. 200 material, thus causing trouble with staying within grading limits and design tolerances.

INTRODUCTION

The Texas State Department of Highways and Public Transportation's (SDHPT) 1982 Standard Speckfications for Construction of Highways, Streets and Bridges (1) specifies under Item 340.3 (3) "Types" that "When properly proportioned, the mineral aggregate shall produce a graduation which will conform to the limitations for master grading given below for the type specified unless otherwise shown on plans. The gradation will be determined in accordance with Test Method Tex-200-F (Dry Sieve Analyses) (2) and shall be based on aggregate only." Furthermore, under Item 340.3 (4) "Tolerances" it is stated the "The aggregate portion of the paving mixture produced shall not vary from the design gradation by more than the tolerances allowed herein. The material passing the No. 200 sieve is further restricted to conform to the limitations for the master grading for the type specified .... The method of test for determining the aggregate gradation and asphalt content of the mixture shall be Test Method Tex-210-F or other methods of proven accuracy." See References 1 and 2.

The important aspect of the above requirements is essentially that sieve analysis will normally be allowed to govern both the design and production of Item 340 hot-mix materials produced and used by the SDHPT. The sieving required in the second item above is also a dry sieving of the resulting aggregates after the extraction test. Although not used normally in hot-mix production or design, a wet method of sieving of aggregates is outlined in Test Method Tex-210-F (2).

With the dry sieve analysis method thus nominally specified in the Texas SDHPT specifications for both design and production monitoring of Item 340 hot-mix aggregate gradations, several questions arise such as:

1. Does the use of dry sieve analysis to evaluate cold-feed or hot-bin aggregate gradations together with the dry sieve analysis performed subsequent to the extraction test tell enough about the characteristics of aggregate combinations in hot-mixes being produced to avoid problems associated with the laying and service performance of hot-mixes?

2. If wet sieve analysis is needed to avoid hot-mix performance problems, should it be used in conjunction with dry sieve analysis during both design and construction production of hot-mixes? Should wet sieve analysis be required to take the place of dry sieve analysis for design or for just production of hot-mixes, or for both?

3. For sieve analysis of Item 340 aggregate gratations in general, would the use of more sieves, such as sieving with the number and sizes of sieves used in concrete testing, enable more needed information to be obtained about aggregate gradations versus that gained using the standardly utilized SDHPT hot-mix sieves? And, would more potential problems with hot-mixes be found by going to sieving in both design and production with the larger number of sieves such as are in the concrete series?

STUDY OBJECTIVES

With the purposes in mind of answering the above questions that have arisen concerning the best method of sieve analysis to use, this study has been conducted with several objectives. These are as follows:

1. The information obtained by wet sieving hot-mix aggregates is to be compared with that gained from dry sieving on the same aggregates to determine whether there is enough additional information gained to justify the additional wet sieving effort. Results from wet sieving will thus be compared with both dry sieving and extraction sieving results.

2. Wet sieving data is to be compared with dry and extraction sieving results for different aggregate and hot-mix plant types to determine what effects these have on sieving results.

3. Wet sieving is to be compared with dry and extractions sieving to determine whether wet sieving would serve as a better predictor of hot-mix performance problems.

4. Screening hot-mix aggregates with the American Society for Testing and Materials (ASTM) standard-sized concrete sieves commonly specified and used by SDHPT (1) is to be compared with screening the same aggregates with SDHPT used sieve sizes to determine whether concrete sieves give enough additional information about the Item 340 aggregate gradings to justify the SDHPT going to these sieves for hot-mix design and production testing.

SAMPLING ACTIVITIES

During the summer and fall of 1982, eight hot-mix plants in six SDHPT districts were sampled from five to eleven days to obtain aggregates for dry and wet sieving and produced hot-mix samples for extraction sieving. Four plants were weigh-batch and four were drum-dryer plants. The districts involved were 4, 9, 11, 15, 17, and 25. In all, a total of 10 different hot-mixes were evaluated during production, including three different mixtures produced during District 15's work at the Affiliated Aggregates drum-dryer plant in San Antonio. The number of samples of aggregates had hot-mix tested for the dry, wet and extraction sieving ranged from 10 to 35 as shown in Tables 1 through 10B, depending on the sampling efforts undertaken for a particular mixture design and plant location. In all, nine Type "D" Item 340 mixtures and one Type "B" mixture were tested.

Samples were obtained by either Texas Transportation Institute (TTI) or SDHPT personnel according to accepted customary practices of SDHPT plant inspectors. Aggregates from weigh-batch plants were taken from the hot-bins and recombined in the correct proportions to comprise a representative production sample. For both types of plant, freshly hot-mix material was taken from the beds of trucks to obtain extraction analysis samples.

As shown in Table 11, the hot-mixes evaluated were predominantly Type "D" mixtures with limestone aggregates comprising the major percentage of the coarse aggregate phase and siliceous field sands rounding out the finer end of the total aggregate grading. As exceptions, District 25's mixture was composed 100 percent of weathered siliceous gravel obtained entirely from crushing material on a hillside overlooking Dickens, Texas. District 11's mixture was composed of 100 percent McCrorey Pit iron ore top soil. Finally, District 17's mixture was comprised of three different materials in an effort to achieve economy, skid resistance and stability on SH 21 west of Caldwell, Texas in Burleson County.

TESTING PROCEDURES

In general, sieving of aggregates for this substudy conformed to the SDHPT's Test Method Tex-200-F, "SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES," "PART I DRY SIEVE ANALYSIS" and "PART II WASHED SIEVE ANALYSIS" (2). Both procedures are based on determining precentages by weight of material passing-retained between various sieve sizes.

Exceptions to the procedure included the use of different reporting forms for sieving results other than those used by the SDHPT. Also, concrete sieves were introduced among the standard SDHPT hot-mix sized sieves for much of the sampling in an effort to compare concrete and hot-mix sieves. The use of concrete sieves is readily apparent in Tables 1 through 6, indicating that the bulk of this comparison work was done with plants in District 15. This particular phase of the evaluation was discontinued beginning with Young Brothers production of Type "D" for District 17 in Table 7. The major exception to the procedure in Test Method Tex-200-F was that most individual samples were sequentially dry sieved and then subjected to washed sieve analysis. These samples were therefore sieved twice, once dry and then the same dry-screened samples were subjected to the washed sieve analysis.

In most instances, the numbers of screen analyses of extractions of produced hot-mix were equal to those of the wet or dry sieve analyses of compined aggregate sample. The exception was that only seven extraction analyses were performed for the hot-mix produced for U. S. 287 in Dumas, Texas as shown in Table 8. Sampling of the produced hot-mixes was timed to occur shortly after the belt or hot-bin aggregate samples were taken to represent as closely as possible the actual hot-mix produced by the aggregates sampled.

DATA RESULTS FROM THE USE OF DIFFERENT SIEVING METHODS

Basic Results

Basic sieving results are summarized in Tables 1 through 10B and Table 11. These tables contain general data about the hot-mix, aggregate sources, SDHPT district, county, SDHPT project number, SDHPT control and section mumber, type of hot-mix plant, number of samples taken and number of days of sampling. Next, the average weight percent values for the amounts of material passing and retained between each set of adjacent sieves by method of sieving are presented in tabular form. Also, statistics are presented for each average of the amounts passing-retained, these being standard deviation (STD. DEV.), and coefficient of variation (C.V.).

Table 1. This table which is representative of Tables 1 through 9 lists average sieving results for the Vulcan Materials weigh-batch plant producing Type "D" hot-mix on SDHPT Projects MC25-9-51 etc. in Bexar County. The period of sampling covered nine days, and 10 total samples were taken. This sampling included 10 combined aggregate samples from the hot-bins where each sample was first dry sieved and then wet or washed sieved according to Test Method Tex-200-F. Ten separate samples of produced hot-mix were then extracted, and an aggregate grading was determined on these by Test Method Tex-210-F.

As shown in Table 1, the percentages of different aggregate types and sizes included coarse and medium sized limestone fractions. The fine material totaled 36.1 percent of the total mix of which 70 percent was siliceous sand and 30 percent was limestone screenings (LSS).

In the main part of Table 1, the actual results of the three sieving methods are given for an average of 10 samples. As noted under the "PASS-RETD SIEVE SIZES" column, the concrete sized sieves (i.e., No's 8, 16, 30, 50 and 100) are interspersed among the standard hot-mix sieves. Between each two adjacent sieves, the average percents of material retained are given. For example, for the No. 40 to No. 50 sieves, 5.1 and 4.9 percents by weight are retained for the dry method and wet methods of sieving, respectively. For the extraction sieve analysis, the percentage passing-retained is 4.9.

Also to be noted is that the plus No. 10 percentages are 63.5 and 63.1 for the dry and wet methods of sieving, respectively. For the extraction sieving result, the average of 10 samples is 64.2 percent. The average minus No. 200 sieve results are 2.1 and 3.7 percents, respectively, for the dry and wet sieving methods. The average percentage for the extraction sieving is 2.4.

Under the column titled "DESIGN" is given the SDHPT District 15's design percentages for this particular mix for the hot-mix sieves. These design values are placed in these tables to serve as comparisons with the results of the three sieving methods.

Most of the three columns of percent values passing-retained should add to 100.0 or close to this value. The percent values for the dry sieving in Table 1 add to 100.2; those for the wet sieving, to 100.1; and those for the extraction sieving results, to 100.1 also. Any difference from 100.0 is due purely to rounding off in the average of the 10 values for each passing-retained interval. The statistical values of standard deviation, "STD. DEV" and coefficient of variation, "C.V.," are derived from each of the 10 sieving result values making up each of the pass-retained average values. Thus, for the wet sieving, the ten individual values of percents passing-retained from the three-eighths-inch to the No. 4 sieve had an average of 35.4 percent, a sample standard deviation (STD. DEV. or S) of 1.8 percent and a coefficient of variation C.V. of 0.1 or 10 percent. The C. V. is equal to the STD. DEV. divided by the average and was rounded off to the nearest 0.1.

The STD. DEV. (S) and the C.V. are measures or indicators of the variability of the data results about the mean. Thus, the higher the STD. DEV. and the higher the C.V., the greater the range of data results that cna be expected, going from one side of the mean to the other. If the STD. DEV. is zero, the C.V. would be zero, and all data values would be equal and also equal to the mean.

The interpretation of the STD. DEV. and C.V. for this study is to show how variable the results of sieving are for material retained within each set of adjacent sieves. An example of this can be gained by looking at the results of dry, wet and extraction sieving on the No. 10 to No. 16 sieve-sized material n Table 1. By all three sieving methods, 3.5 percent by weight of material is retained between these two sieves. However, the STD. DEV. is 0.5 for wet and dry sieving as compared with 1.1 for the extraction sieving. Therefore, the C.V. for the extraction sieving is approximately 0.3 or 3 percent compared with 0.1 or 10 percent for the first two sieving methods. Thus, although the 10 extraction results have the same average, the range of these values is much greater and there is greater variability in these values compared with the first two sieving methods.

Tables 10, 10A and 10B. Table 1 through 9 are all set up using the same system, and Tables 10 through 10B are organized slightly different. Table 10 contains all of the 30 gradation and extraction samples submitted fron one hot-mix production job done by Downing Brothers, Inc., for SDHPT District 9 in McClennan County. This project started up for a few days in August, 1982, then shut down until September 7, 1982. Thus, the hot-mix was produced in two distinct periods. Tables 10A and 10B therefore were added to reveal the characteristics of each of these two distinct periods within the project production and then compare these against those for the total sampled production as listed in Table 10.

Table 11. Table 11 presents a summary of the nature of the aggregate compositions used in the hot-mixes evaluated in this sieving sub-study. As seen in this table, the predominant coarse aggregate material used in the hot-mixes studied was limestone, with siliceous sands figuring largely in the fine materials used in the mixtures. Two hot-mixes, very different from the majority, were those sampled from District 25 and District 11. These consisted

entirely of crushed gravel and pit run iron ore, respectively.

Enhanced Data Results

Tables 12 through 27 and Figures 1 through 24 represent tabular refinements and graphical presentations of the data results from Tables 1 through 10B. Figures 17 through 24 apply to the concrete sieves versus hot-mix sieves part of the sieving substudy.

Tables 12 through 21. These 10 tables are derived from Tables 1 through 10. These show net changes in percentages of material retained between adjacent sieves going from one sieving method to another.

Table 12 is taken as an example. Taking the percentages of material passing the No. 16 sieve and retained on the No. 30 sieve, Table 12 extracts the differences from Table 1. Going from dry to set sieving, the average percent retained between the two sieves went from 4.6 to 4.5; thus, there was a decline of 0.1 percent or a change of -0.1 percent.

Going from dry to extraction sieving, the difference shown in Table 12 (from 4.6 to 5.0 percent in Table 1) is + 0.4 percent. The above precedure holds for all the other sieve size intervals in Tables 12 through 21.

Figures 1 through 10. These figures are graphical presentations of the enhanced data results given in Tables 12 through 21 for showing the differences from going from dry to wet sieving only. These figures appear useful for showing the sieve sizes or intervals where material seems to be washing off of and the sizes where the washed off material is going to.

Figures 11 and 12. These two figures show the relationships of the results for the averages of dry, wet and extraction sieving for the plus No. 10 and minus No. 200 sieves in comparison with the hot-mix design gradation requirements for these two sieves. As an example, in Figure 11 the positions of the result averages for dry, wet and extraction screening for the plus No. 10 material for the Affiliated Aggregates drum-dryer produced Type "D" "Surface" hot-mix are shown on the percentage scale. Also shown is the position of the design grading requirement for the plus No. 10 sieve material. These values are taken from Table 3 and show that the average dry, wet and extraction results lie at percentages of 62.0, 60.9 and 59.7 compared with 64.5 for the design requirement.

Figure 12 employs the same system for showing relative positions of sieving result averages for the minus No. 200 sieve material. Taking the same Affiliated Aggregates materials from Table 3 again, it is shown that the average wet sieving results exceed the design requirement, being 6.0 and 4.7 percent respectively. The extraction and dry sieve analyses averages lie at lower percents than design, at 2.4 and 3.9 percent, respectively.

Tables 22 through 24. These tables show the overall net differences between design requirements and the average percentages of total material actually retained on the No. 10 sieve for the 285 substudy. Table 22 provides these figures based on all the hot-mix plants studied and by method of sieving. Thus, in Table 22, for all the hot-mix plants and hot-mixes studied, for the dry sieving, an overall difference of plus 2.6 percent or 2.6 percent more material is shown retained on the No. 10 sieve as versus the design requirement. For wet sieving, this figures drops to plus 1.0 percent, and for extraction sieving, the figure falls to plus 0.2 percent material retained as versus the design requirement.

Table 23 provides these differences in sieving averages obtained versus design requirements for the six drum-dryer plant produced hot-mixes only. Finally, Table 24 gives these differences for the four weight-batch plant produced hot-mixes. (Tables 23 and 24 combined give the same results as shown in Table 22).

Figures 13 and 14. Figure 13 is a graphical representation of the data given in Table 22. Figure 14 presents the data results contained in Tables 23 and 24 for the drum-dryer and weigh-batch produced hot-mixes, respectively.

Tables 25 through 27. These tables are similar in function to Tables 22 and 24. They show the overall net differences from design requirements for the averages of material found passing the No. 200 sieve by method of sieving. Table 25 covers all of the hot-mix plants and produced hot-mixes. Table 26 illustrates the results for the six drum-dryer plant produced hot-mixes, and Table 27 shows the data results for the four weigh-batch plant produced hot-mixes.

In Table 25, the overall net difference between the average amount of material found passing the No. 200 sieve for the wet sieving method and the design requirement is 2.5 percent. Thus, the wet sieving method found 2.5 percent more material on the average passing the No. 200 sieve. In Table 26, this difference for wet sieving averaged 3.0 percent for the drum-dryer plants. In Table 27 the difference for wet sieving for the weigh-batch plants averaged 1.7 percent.

Figures 15 and 16. These figures are graphical presentations of the data results in Tables 25 through 27. Figure 15 gives the results for Table 25, and Figure 16 combines and illustrates the results for Tables 25 and 27.

Figures 17 through 24. These figures extract and illustrate data from Tables 1, 4 and 5 concerning the use of concrete sieves versus hot-mix sieves for Item 340 hot-mix asphaltic concrete design and construction monitoring. Data results are illustrated for the hot-mix production evaluated from the Vulcan Materials, McDonough Brothers and Affiliated Aggregates plants located north of San Antonio in SDHPT District 15.

As shown in these figures, the results of using the SDHPT hot-mix screens are shown with the solid lines. The concrete screens sieving results are shown in the dashed lines. From Figures 17, 18 and Table 1, the results of using the concrete screens versus the hot-mix screens are shown for the wet and extraction sieving methods. From Figures 19 through 24, and Tables 4 and 5, concrete versus hot-mix screens results are shown for all three sieving methods - dry, wet and extraction.

DISCUSSION OF RESULTS

Wet Versus Dry Sieving

Figures 1 through 10. These figures illustrate the average net changes in gradation characteristics of the materials sieved in Tables 1 through 10B, going from dry to wet sieving. In general, in moving from dry to wet sieving on the same materials most of the loss in material retained between adjacent sieves occurs from the aggregate top size down to the No. 80 to the No. 100 sieve sizes. Below these sizes, there is generally a gain, especially in the minus No. 200 sieve material. Also, there is usually some loss between each sieve size bracket; however, some scattered gains occur in some brackets, but these are usually very small, of the order of from zero to 1.0 percent. All but Figure 5 illustrate this tendency.

Figure 5 shows several sieve intervals with somewhat larger gains in material scattered from the No. 4 down to the minus No. 200 sieve material. To help achieve these gains approximately two percent of material is lost from the three-eighths-inch sieve to the No. 4 sieve and from the No. 16 to the No. 30 sieve.

Other figures showing considerable losses from one to three percent in three to four sieve size brackets or intervals are Figures 6 through 9. These losses are more significant in Figures 7 through 9 because the sieve size intervals or brackets are larger since only hot-mix sieves are used.

Since the losses in the upper sieving brackets naturally add to the material passing the No. 200 sieve, it should be noted how much the material passing the No. 200 sieve is increasing going from dry to wet sieving. For all of the hot-mixes studied as based on Tables 1 through 10, the average increase is 3.7 percent and the range is from 1.5 to 6.1. For the hot-mixes produced by drum-dryer plants, the average increase in 4.5 percent, and the range is from 3.6 to 6.1. For the weigh-batch plants, the average is 2.5 percent and the range is 1.5 to 5.1.

Thus, concerning material passing the No. 200 sieve as seen above, the drum-dryer plants give rise to the larger differences between the results for dry sieving and the results for wet sieving. A question then arises as to how far from the design required values are the averages for the three sieving methods. As seen in Table 22, for all plants and hot-mixes studied, the average differences between the dry, wet and extraction methods and design are -1.2, 2.5 and 0.3 percent, respectively, and are thus seen to be fairly close to design. The ranges of average difference values is from -0.1 to -2.3 percent for dry sieving; 0.5 to 5.2 percent for the wet sieving and -1.6 to 2.2 for the extraction sieving.

Two requirements are placed upon the SDHPT hot-mix paving mixtures in the 1982 SDHPT specifications in Section 340.3 (4). These are (1) that "The aggregate portion of the paving mixture produced shall not vary from the design gradation by more than the tolerances allowed herein," and (2) that "The material passing the No. 200 sieve is further restricted to conform to the limitations for the master grading for the type specified .... The method of test for determining the aggregate gradation and asphalt content of the mixture shall be Test Method Tex-210-F or other methods of proven accuracy." See Reference 1. Therefore, for a Type "D" ("Fine Graded Surface Coarse") hot-mix the master gradation requires from one to eight percent of aggregate material for a tested mixture to pass the No. 200 sieve. Also, the tested paving mixture should not differ from the designated or design grading by more than plus or minus five percentage points for the aggregate passing-retained intervals above the No. 10 sieve and plus or minus three percentage points for those below the No. 10 sieve.

To see whether using wet sieving for design and production testing of aggregate gradations would preclude problems of staying within specification limits as stated above, Figures 1 through 10 and Tables 12 through 21 can be consulted. If dry sieving is used for design and also during production, and this sieving shows the aggregate mixture to be close to the design target for each aggregate range, then Tables 12 through 21 show no bad problems on the average of staying within tolerances based on the results of dry and wet sieving of hot-bin and cold feed belt aggregate samples. However, Tables 18, 19 and 20 do show three mixtures that approach or exceed the three percentage points tolerance for one sieve size interval.

For the data taken in this study the problem occurs more with the minus No. 200 sieve material. Here, Tables 13, 14 and 18 show mixtures that approach or equal the five percentage points tolerance and Tables 19 and 20 show mixtures exceeding the tolerance on average. Also, because the tolerances are exceeded, the chances are greater for exceeding the master gradations, depending on the position of the design value. As another check on whether wet screens could be usefully employed, Tables 12 through 21 again may be consulted. In this case the average difference between dry and extraction sieving should be noted. As opposed to the differences between dry and wet screening, the problem with exceeding design tolerances apparently lies not so much with the minus No. 200 sieve as it does with the plus No. 10 sieve size intervals. Thus, by making the same assumption about the dry screen results being close to or on the design value, tolerances are apparently exceeded in Tables 13, 15, 18 and 19 are are close to being exceeded in Tables 16 and 17.

Since the extraction sieving Test Method Tex-210-F is both specified and commonly used to check aggregate gradations in produced mixtures, it appears from this study's results that designing by dry screens could give problems of keeping gradations within specification limits and tolerances. Figures 11 and 12 below, based upon Tables 1 through 10, will show some of these problems being encountered.

<u>Figures 11 through 16</u>. Figure 11 illustrating the percentage positions of the averages of the total plus No. 10 sieve materal retained by method of sieving, as versus the design percentage position, shows the five percentage points tolerance being exceeded on the average for the five hot-mixes evaluated in Tables 1, 2, 6, 7 and 9, for one or more methods of sieving. Dry sieving exceeded the tolerance on three occasions; wet, on four and extraction on four. Two of these hot-mix plants are weigh-batch, and three are drum-dryer. Three aggregate materials consisted largely of limestone materials, one was entirely crushed gravel and one was entirely iron ore top soil.

As shown in Figure 11, dry sieving exceeds the tolerance on the high side on three occasions and on the low side once. Wet sieving exceeds the tolerance on the No. 10 sieve on the high side twice and on the low side once. Extraction sieving exceeds the tolerance on the high side and on the low side for two times each. Therefore, there seems to be no apparent trend as to why the tolerances are exceeded based on plant type, aggregate type and mode of sieving.

Concerning which method of sieving approaches most closely the specified design value, Figures 13 and 14 should be referred to. Figure 13 shows that for all 10 hot-mixes produced by the eight different hot-mix plants the extraction method of sieving on the average comes within 0.2 of one percent of (above) the specified design value. The wet sieving method showed average results that come within 1.0 percent of (above) the design value. The dry sieving method rises 2.6 percent on the average above the specified design value.

Figure 14 shows the different or separate effects of the weigh-batch and drum-dryer plants on the average results of material retained on the plus No. 10 sieve as versus design. For all sieving methods, the weigh-batch plants show from about 3.5 to 4.5 percent more material retained on the No. 10 sieve than the design. The dry sieving method is the most severe in this case. The drum-dryer plants grade downward from showing more plus No. 10 material for dry sieving to showing over two percent less material for extraction sieving. For wet sieving, average results for the drum-dryers come to about one-half percent less material than design.

Figure 12 illustrates the percentage positions of the average amounts of material passing the No. 200 sieve by method of sieving and compared with the design requirements. This is done for each of the hot-mix and hot-mix plant combinations studied. As shown in Figure 12, the tolerance from design of three percent is exceeded on the average for only three hot-mixes from Table 6, 8 and 9. In each of these instances, only the wet method of sieving shows to be out of tolerance and is out on the high side as would be expected. For every occasion, as shown in Figure 12, the wet sieving method produces the highest average percentage passing the No. 200 sieve. In all instances except for Table 9, the dry method of sieving shows the least amount of material on the average passing the No. 200 sieve which also seem reasonable. The extraction sieving results tend to fall closer to the design, with six of ten tables showing this feature.

Figure 15 and 16 illustrate more graphically which method of sieving most closely approaches the design requirements. As shown in Figure 15, for all hot-mixes and hot-mix plants studied, the extraction method of sieving comes the closest to meeting the design requirement on the average, being slightly above. The next closest is dry sieving which shows about one percent less than design on average. Wet sieving on the average shows about two and one-half percent more material passing the No. 200 sieve than the design requirement.

Figure 16 shows the effects of the two different plant types on the material passing the No. 200 sieve. As shown in Figure 16, for extraction sieving, both plant types produced averages near design, the drum-dryer plants showing somewhat more material passing and the weigh-batch plants somewhat less. For wet sieving, the drum-dryer plants show a little more than three percent greater than design and thus approach or exceed the tolerance for the minus No. 200 sieve material. For dry sieving, the drum-dryer plants show about one and one-half percent less material passing the No. 200 sieve in relation to design.

In all of the discussion above concerning Figures 11 through 16, one main assumption made is that the hot-mixes that were produced and evaluated in this substudy were targeted at the design gradations shown during production. No information concerning any difficulties encountered in keeping the produced mixtures on track with the design gradings was made available during the gathering of data. Another assumption made is that the samples taken were representative of the mixtures produced.

Variability of Sieving Data

In order to get a rough estimate of the variability in the sieving results from one sieving method to another and from one hot-mix plant to another, the C.V., coefficient of variation, columns in Tables 1 throug 10 should be referred to. To make the comparison, the average was taken of all these C.V. values listed in each column, for each table and each method of sieving.

As a result, the average C.V. values for dry, wet and extraction sieving for all of the tables are 0.24. 0.22 and 0.21, respectively, showing about equal overall variability in the data results, with the extraction data indicating to be the least variable. Considering weigh-batch plants alone, the overall average C.V. values are 0.22, 0.19 and 0.21 for the three methods of sieving, respectively; and for drum-dryer plants are 0.26, 0.25 and 0.20, respectively. Thus, in rough comparison with the weigh-batch plants, the drum-dryer plants show from 18 to 32 percent more overall variability on the average for dry and wet sieving results, respectively, and about the same overall variability for the extraction results.

Individual hot-mixes and hot-mix plants that show the highest variability as indicated by C.V. values included thse in Tables 2 and 5 which represent drum-dryer plants. Those that show the least variability include the plants in Tables 1, 7 and 8, representing one weigh-batch and two drum-dryer plants respectively. Thus, drum-dryer plants show the greater range in variability, with weigh-batch plants tending to fall in the middle of the drum-dryer range.

One District's Experience. In the summer of 1982, SDHPT District 17 placed a skid resistant Item 340 Type "D" hot-mix surface course on SH 36 from the south City Limit of Caldwell north ot the Burleson-Milam county line. This hot-mix consisted of the following aggregate combination which is similar to that of Table 7: 32.5 percent Texas crushed stone limestone coarse aggregate, 32.5 percent Delta Materials Grade 5 crushed sandstone, 15.0 percent Texas Crushed Stone limestone screenings and 20 percent of a siliceous field sand. The percent by weight of asphalt used ranged from 5.5 to 5.7, and Dow-Corning M 200 antistrip agent was employed.

The above described hot-mix had a minus No. 200 sieve design requirement of 5.6 percent, but during production of the mix in a drum-dryer plant the minus No. 200 material was consistently found by extraction to range from 7 to 8.3 percent by weight of mixture. Thus, under the 1972 SDHPT standard specifications (3), this produced mixture both exceeded the tolerance for the design and the requirements for the master grading. Had a check by wet screening of the aggregate materials been conducted during the design phase for this hot-mix, the subsequent problems encountered with staying within the specifications may have been avoided by adjustment downward of the minus No. 200 material during the design phase.

Although greater than design amounts of minus No. 200 sieve material apparently went out on SH 36 according to extraction results, no serious problems apparently were encountered on the roadway. The increase in fines did lead to increasing the asphalt content from 5.5 to 5.7 percent during production.

Concrete Sieves Versus Hot-Mix Sieves

Figures 17 through 24 illustrate the comparison of using concrete sieves versus the hot-mix sieves normally used by the Texas SDHPT for design and production monitoring of hot-mixes. As seen in these figures the concrete sieve result curves are coincident from the one-half-inch to the No. 4 sieve, diverge from the hot-mix curves at the No. 4 sieve and converge again at the No. 200 sieve.

Each of the figures typically shows the concrete sieve curve staying very close to the hot-mix curve. (The two curves on each figure represent sieving of the same material sample using two stacks of nested sieves). Of the small differences that exist, the greatest on each figure is seen to lie between the No. 10 and 40 sieves, with the concrete sieve curves running from two to four percentage points above the hot-mix sieve curve values.

The significance of the concrete screeen curves beign higher in the No. 10 to No. 40 range is that more fine material is being detected from the No. 30 sieve to passing to No. 200 sieve. Also, the concrete sieves are detecting a somewhat higher hump at the Nl. 30 sieve and are thus indicating slightly more potential for problems with stability because of the nature or shape of the aggregate grading curve.

If concrete screens were adopted in place of the hot-mix sieves, several disadvantages would probably accrue. One would be that two more screens would be required than normally used for hot-mix sieves, and two more pass-retained intervals would have to be reckoned with during design and production testing. Another disadvantage would be that separate sets of sieves would probably still have to be maintained for concrete work and hot-mix work because of rapid sieve wear, the need to continually check sieve wear to ensure sieving accuracy, and the need to maintain separate concrete and hot-mix operations out of a residency or district office. A third disadvantage could possibly be a temporary "loss of feel" by personnel accustomed to using hot-mix screens during many years of experience.

CONCLUSIONS

Wet Sieving Versus Dry Sieving

1. For the hot-mixes evaluated in this study, going from dry to wet sieving on the same aggregate samples produced significant differences (increases) only for the amounts of material passing the No. 200 sieve, for both weigh-batch and drum-dryer plants.

2. For this study's mixes, going from dry to extraction sieving (using different samples for each method) produced the greatest differences in the sieve sizes above the No. 10 or No. 8 sieves. The increases for the minus No. 200 material were not as great as for going from dry to wet sieving.

3. For the total material retained on the No. 10 sieve, average wet sieving results most closely approached the designated hot-mix design values, with the results being closer but underpredicting for drum-dryer plants.

4. For the total material passing the No. 200 sieve, average results, for all the hot-mixes and hot-mix plants, of extraction sieving closely approached the design requirements. Both the wiegh-batch and drum-dryer plant extraction sieving results approached closely design requirements on the average.

5. Based on coefficient of variation (C.V.) values, drum-dryer plants had the greater range of sieving results variability. However, sieving results for two drum-dryer plants were among the three least variable results, and the three other weigh-batch plants had results more variable than those two drum-dryer plants.

6. The experience of one SDHPT district with hot-mix producing excessive minus No. 200 material in 1982 points to the possible need in some instances for wet sieving during the design stage to indicate and correct those mix design that may yield excessive fines during production.

7. Although not discussed previously in this report, the time and effort required to run a wet sieve are estimated to be from two to three times that for the dry sieve analysis as prescribed in Test Method Tex-200-F (2).

Concrete Sieves Versus Hot-Mix Sieves

1. Little, if any, additional information appears to be gained about hot-mix aggregate gradations, above that normally found using regular SDHPT hot-mix sieves by going to the use of the ASTM series of standard sieves for concrete for the design and production of hot-mix. This conclusion is based on the grading curves contained in Figures 17 through 24.

2. The concrete sieves appear to have a tendency to show hot-mix aggregate gradings with more material between the No. 30 and No. 200 sieves and to show more of a hump at the No. 30 sieve.

RECOMMENDATIONS

1. The requirement of the general use of wet sieving during both design and production of hot-mixes is not warranted.

2. There may be instances when the use of wet sieving during the the design stage may be advantageous if a proposed hot-mix design is suspected to be a potential generator of excessive fines during production. If wet sieving reveals this during design, then the mix can be adjusted during the design stage.

3. The SDHPT general practice of dry sieving for design and dry sieving plus extraction sieving for monitoring hot-mix production should be continued in all but those instances where wet sieving might serve to determine an excessive generator of fines.

4. The replacement of SDHPT hot-mix sieves with ASTM concrete sieves for the design and production of hot-mix is not warranted.

REFERENCES

1. _________, Texas State Department of Highways and Public Transportation 1982 Standard Specifications for Construction of Highways, Streets and Bridges, State Department of Highways and Public Transportaton, adopted by the Department, September 1, 1982.

2. _________, Manual of Testing Procedures, 200-F Series, Bituminous Section, State Department of Highways and Public Transportation, revision published by the Department, January, 1978.

3. _________, Texas Highway Department 1972 Standard Specifications for Construction of Highways, Street and Bridges, Texas Highway Department, adopted by the Department, 1972.

Table 1. Basic results of wet versus dry sieving for Item 340 Type "D" hot-mix production from Vulcan Materials weigh-batch plant.

PRODUCER: VULCAN MATERIALS
TYPE PLANT: WEIGH-BATCH
DAYS SAMPLED: 9
NO. OF SAMPLES: 10
HOT-MIX DESIGN: TYPE "D" SURFACE
AGGREGATES:

1. Coarse, Limestones Grade 4 & 5, 36.7%
2. Medium, Sandstone Grade 4 & 5, 22.3%
3. Fines (70% Silica & 30% LSS), 36.1%
4. Asphalt. 4.9%

DISTRICT: 15
COUNTY: BEXAR
PROJECTS: MC25-9-51
MC17-10-131
CONTROL: 25-9-51 ETC.

AVERAGES FOR 10 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0	0	0	0	0	0	0	0	0	0.0
1/2" - 3/8"	10.8	3.5	0.3	10.5	3.4	0.3	8.8	2.5	0.3	9.1
3/8" - 4	35.3	2.2	0.1	35.4	1.8	0.1	34.9	4.1	0.1	30.2
4 - 8	15.3	2.3	0.2	15.3	2.3	0.2	18.0	3.2	0.2	
8 - 10	2.1	0.5	0.2	1.9	0.6	0.3	2.5	0.7	0.3	18.6
+ 10	63.5	0.9	0.0	63.1	0.8	0.0	64.2	4.9	0.1	57.9
10 - 16	3.5	0.5	0.1	3.5	0.5	0.1	3.5	1.1	0.3	
16 - 30	4.6	0.5	0.1	4.5	0.6	0.1	5.0	1.8	0.4	
30 - 40	2.9	0.5	0.2	2.8	0.5	0.2	2.6	0.5	0.2	10.2
40 - 50	5.1	0.3	0.1	4.9	0.3	0.1	4.9	1.4	0.3	
50 - 80	11.5	1.0	0.1	11.6	1.8	0.2	11.2	2.8	0.3	18.8
80 - 100	4.3	0.6	0.1	3.6	1.0	0.3	3.7	0.7	0.2	
100 - 200	2.7	0.4	0.1	2.4	0.5	0.2	2.6	0.7	0.3	9.9
- 200	2.1	0.9	0.4	3.7	1.3	0.4	2.4	0.4	0.2	3.2

NOTE: STD. DEV. = Standard Deviation
C. V. = Coefficient of Variation (%) = $\frac{\text{STD. DEV.}}{\text{AVERAGE}}$

Table 2. Basic results of wet versus dry sieving for Item 340 Type "B" hot-mix production from Affiliated Aggregates drum-dryer plant.

PRODUCER: AFFILIATED AGGREGATES
TYPE PLANT: DRUM-DRYER
DAYS SAMPLED: 9
NO. OF SAMPLES: 10
HOT-MIX DESIGN: TYPE "B" (Fine graded base etc.)
AGGREGATES:

1. Limestone, Grade 3, 27.6%
2. Limestone, Grade 4, 20.0%
3. Limestone, Grade 6, 15.2%
4. Limestone Screenings, 11.4%
5. Sandstone, 21.0%
6. Asphalt. 4.8%

DISTRICT: 15
COUNTY: BEXAR
PROJECT: MQ 017(2)
CONTROL:

AVERAGES FOR 10 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	8.9	6.9	0.8	8.8	6.9	0.8	4.7	1.7	0.4	0.0
1/2" - 3/8"	14.6	2.6	0.2	14.1	2.7	0.2	11.6	1.2	0.1	21.1
3/8" - 4	28.4	7.8	0.3	27.8	7.5	0.3	29.1	4.4	0.2	33.0
4 - 8	10.0	2.9	0.3	9.7	2.2	0.2	13.3	1.5	0.1	
8 - 10	1.2	0.7	0.6	1.2	0.7	0.6	1.1	0.2	0.2	12.8
+10	63.1	7.7	0.1	61.6	7.0	0.1	59.8	2.9	0.0	66.9
10 - 16	1.3	0.4	0.3	1.1	0.4	0.4	2.0	0.3	0.2	
16 - 30	2.8	0.7	0.3	2.8	0.4	0.1	3.1	0.7	0.2	
30 - 40	4.1	0.9	0.2	3.7	1.0	0.3	3.6	0.9	0.3	10.2
40 - 50	7.9	3.1	0.4	6.8	2.3	0.3	7.7	1.1	0.1	
50 - 80	11.8	2.2	0.2	11.4	2.5	0.2	13.1	1.4	0.1	15.4
80 - 100	3.1	1.3	0.4	2.9	1.3	0.4	3.3	0.5	0.2	
100 - 200	3.5	1.1	0.3	3.5	0.8	0.2	3.8	0.5	0.1	3.6
- 200	2.4	0.7	0.3	6.2	0.8	0.1	3.8	0.6	0.2	3.9

NOTE: STD. DEV. = Standard Deviation C.V. = Coefficient of Variation $= \frac{\text{STD. DEV.}}{\text{AVERAGE}}$

Table 3. Basic results of wet versus dry sieving for Item 340 Type "D" hot-mix production from Affiliated Aggregates drum-dryer plant.

PRODUCER: AFFILIATED AGGREGATES
TYPE PLANT: DRUM-DRYER
DAYS SAMPLED: 7
NO. OF SAMPLES: 10
HOT-MIX DESIGN: TYPE "D" SURFACE
AGGREGATES:
1. Gr. 4 Limestone, 36.0%
2. Gr. 6 Limestone, 29.0%
3. Limestone Screenings, 10.0%
4. Sandstone. 25.0%

DISTRICT: 15
COUNTY: BEXAR
PROJECTS: 15-2-1720
15-2-1710
15-2-1700
MC421-4-20
CONTROL: 15-2-1720 ETC.

AVERAGES FOR 10 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0.1			0.0			0.1			0.0
1/2" - 3/8"	12.4	2.1	0.2	12.0	1.9	0.2	9.4	3.8	0.4	4.8
3/8" - 4	36.8	4.0	0.1	36.6	3.7	0.1	35.0	4.3	0.1	38.8
4 - 8	11.4	2.8	0.2	11.2	2.6	0.2	13.8	3.9	0.3	
8 - 10	1.3	0.7	0.5	1.1	0.6	0.5	1.4	0.6	0.4	20.9
+ 10	62.0	4.1	0.1	60.9	3.8	0.1	59.7	6.0	0.1	64.5
10 - 16	1.8	0.6	0.3	1.5	0.2	0.1	2.2	0.6	0.3	
16 - 30	2.4	0.8	0.3	2.5	0.5	0.2	3.6	1.1	0.3	
30 - 40	4.6	1.4	0.3	3.5	1.1	0.3	4.2	1.1	0.3	9.2
40 - 50	8.3	1.6	0.2	7.3	1.0	0.1	8.1	1.8	0.2	
50 - 80	12.0	2.0	0.2	11.7	2.1	0.2	11.5	3.4	0.3	16.3
80 - 100	3.6	1.1	0.3	3.3	1.2	0.4	3.6	1.4	0.4	
100 - 200	3.2	0.7	0.2	3.3	0.7	0.2	3.4	0.8	0.2	5.3
- 200	2.4	0.8	0.3	6.0	0.8	0.1	3.9	0.8	0.2	4.7

NOTE: STD. DEV. = Standard Deviation C.V. = Coefficient of Variation = $\frac{\text{STD. DEV.}}{\text{AVERAGE}}$

Table 4. Basic results of wet versus dry sieving for Item 340 Type "D" hot-mix production from McDonough Brothers weigh-batch plant.

PRODUCER: McDONOUGH BROTHERS
TYPE PLANT: WEIGH-BATCH
DAYS SAMPLED: 7
NO. OF SAMPLES: 10
HOT-MIX DESIGN: TYPE "D" SURFACE
AGGREGATES:
1. Sandstone, Grade 4, 4.0%
2. Limestone, Grade 4, 33.5%
3. Limestone, Grade 6, 24.0%
4. Silica Sand, 33.7%
5. Limestone Fabricated Sand.

DISTRICT: 15
COUNTY: BEXAR
PROJECTS: C253-4-74
MQ114(4)
CRP2440-1-12
CONTROL: 253-4-74

AVERAGES FOR 10 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0.1	0.1	1.0	0.0	0		0.0			0.0
1/2" - 3/8"	7.2	2.2	0.3	7.2	2.3	0.3	7.7	3.0	0.4	10.5
3/8" - 4	33.9	1.8	0.1	33.5	2.1	0.1	30.9	2.9	0.1	30.4
4 - 8	21.5	2.3	0.1	21.6	2.2	0.1	22.5	2.8	0.1	
8 - 10	1.8	0.5	0.3	1.6	0.7	0.5	1.9	0.3	0.2	22.4
+ 10	64.5	1.5	0.0	63.9	1.5	0.0	63.0	1.3	0.0	63.3
10 - 16	1.7	0.6	0.4	1.8	0.6	0.3	2.4	0.5	0.2	
16 - 30	2.8	0.6	0.2	2.7	0.6	0.2	3.3	0.7	0.2	
30 - 40	3.3	0.8	0.2	3.1	0.8	0.3	3.3	1.0	0.3	9.9
40 - 50	6.2	0.9	0.1	6.2	0.7	0.1	6.6	0.8	0.1	
50 - 80	11.6	1.8	0.2	11.1	1.5	0.1	10.9	2.1	0.2	17.3
80 - 100	2.8	1.0	0.4	2.9	0.9	0.3	2.8	1.0	0.4	
100 - 200	3.9	1.0	0.3	3.7	0.6	0.2	3.7	0.6	0.2	6.3
- 200	3.1	0.8	0.3	4.6	1.0	0.2	4.1	1.4	0.3	3.2

NOTE: STD. DEV. = Standard Deviation   C.V. = Coefficient of Variation $= \frac{\text{STD. DEV}}{\text{AVERAGE}}$

Table 5. Basic results of wet versus dry sieving for Item 340 Type "D" "Tight" hot-mix production from Affiliated Aggregates weigh-batch plant.

PRODUCER: AFFILIATED AGGREGATES
TYPE PLANT: DRUM-DRYER
DAYS SAMPLED: 7
NO. OF SAMPLES: 10
HOT-MIX DESIGN: TYPE "D" "TIGHT"
AGGREGATES:
1. Grade 4. Limestone, 32.0%
2. Grade 6, Limestone, 25.0%
3. Limestone (Fabricated Sand), 12.0%
4. Silica Sand. 31.0%

DISTRICT: 15
COUNTY: ATASCOSA ETC.
PROJECTS: MC421-4-20
CRP658-1-23
MQ 017(2)
ID 35-2(134)
CONTROLS: 421-4-20 ETC.

AVERAGES FOR 10 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0.5	0.5	1.0	0.3	0.3	1.0	0.3	0.2	0.7	0.0
1/2" - 3/8"	8.0	4.8	0.6	7.7	4.8	0.6	7.6	5.0	0.7	3.0
3/8" - 4	36.8	5.0	0.1	34.9	5.2	0.1	34.8	5.0	0.1	36.5
4 - 8	14.9	4.7	0.3	14.0	4.3	0.3	17.5	5.5	0.3	
8 - 10	2.5	1.1	0.4	2.7	1.7	0.6	1.7	0.4	0.2	17.9
+ 10	62.7	6.4	0.1	59.6	6.3	0.1	61.9	4.7	0.1	57.4
10 - 16	2.0	1.4	0.7	1.2	0.9	0.8	2.3	1.0	0.4	
16 - 30	4.5	2.3	0.5	2.8	1.2	0.4	3.5	0.8	0.2	
30 - 40	4.5	2.4	0.5	4.8	2.1	0.4	3.6	0.8	0.2	12.9
40 - 50	7.0	1.6	0.3	6.1	2.0	0.3	7.0	1.2	0.2	
50 - 80	11.4	2.8	0.2	12.3	2.5	0.2	12.3	2.0	0.2	20.8
80 - 100	2.4	1.2	0.5	2.4	1.3	0.5	2.9	1.2	0.4	
100 - 200	2.8	1.0	0.4	3.3	0.5	0.2	3.2	0.5	0.2	4.6
- 200	2.5	1.2	0.5	7.5	1.9	0.3	3.3	0.5	0.2	4.3

NOTE: STD. DEV. = Standard Deviation C.V. = Coefficient of Variation $= \frac{\text{STD. DEV.}}{\text{AVERAGE}}$

Table 6. Basic results of wet versus dry sieving for Item 340 Type "D" hot-mix production from Gilvin-Terrell Contractors drum-dryer plant.

PRODUCER: GILVIN-TERRELL CONTRACTORS
TYPE PLANT : DRUM-DRYER
DAYS SAMPLED: 5
NO. OF SAMPLES: 15
HOT-MIX DESIGN: TYPE "D" SURFACE
AGGREGATES:
1. Coarse, +10 Gravel, 62.3%
2. Medium, 10-80 Gravel, 29.6%
3. Fines, -80 Gravel. 8.1%

DISTRICT: 25
COUNTY: DICKENS
PROJECT: C132-1-32 ETC.
CONTROL: 132-1-32

AVERAGES FOR 15 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0	0	0	0	0	0	0	0	0	
1/2" - 3/8"	6.6	1.6	0.2	6.3	1.3	0.2	4.7	1.2	0.3	4.1
3/8" - 4	28.8	4.2	0.1	28.1	3.8	0.1	24.3	2.3	0.1	30.8
4 - 8	24.1	1.9	0.1	22.8	3.6	0.2	23.1	1.5	0.1	27.4
8 - 10	4.1	0.4	0.1	4.5	2.4	0.5	4.3	0.4	0.1	
+ 10	63.6	8.0	0.1	61.7	7.9	0.1	56.4	7.3	0.1	62.3
10 - 16	10.7	1.1	0.1	9.6	1.1	0.1	11.2	0.8	0.1	
16 - 30	9.0	1.4	0.2	7.7	1.3	0.2	9.8	0.7	0.1	
30 - 40	3.3	0.7	0.2	3.4	1.6	0.5	3.4	0.2	0.1	22.2
40 - 50	2.9	0.8	0.3	2.6	0.6	0.2	3.1	0.2	0.1	
50 - 80	4.0	1.4	0.4	3.9	0.8	0.2	4.4	0.5	0.1	7.4
80 - 100	1.9	1.0	0.5	2.0	0.6	0.3	2.3	0.2	0.1	
100 - 200	2.7	1.1	0.4	2.7	0.8	0.3	4.2	0.3	0.1	5.1
- 200	1.9	0.8	0.4	6.4	1.2	0.2	5.2	0.7	0.1	3.0

NOTE: STD. DEV. = Standard Deviation C.V. = Coefficient of Variation = $\frac{\text{STD. DEV.}}{\text{AVERAGE}}$

Table 7. Basic results of wet versus dry sieving for Item 340 Type "D" hot-mix production from Young Brothers, Inc., drum-dryer plant.

PRODUCER: YOUNG BROTHERS CONTRACTORS, INC.
TYPE PLANT: DRUM - DRYER PLANT OF SH 21 WEST OF BRYAN
DAYS SAMPLED: 6
NO. OF SAMPLES: 10
HOT-MIX DESIGN: ITEM 340 TYPE "D" SURFACE
AGGREGATES:

1. Texas Crushed Stone "D" Rock, 33 %
2. Delta Materials Sandstone, 27 %
3. Texas Crushed Stone Limestone Screenings, 16 %
4. Heath Pit Field Sand, Gause, Texas, 17.8%
5. Asphalt. 6.2%

DISTRICT: 17
COUNTY: BURLESON
PROJECT: SH 21 FROM CALDWELL TO LEE COUNTY LINE
CONTROL: 116-2

AVERAGES FOR 10 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0	0	0	0	0	0	0	0	0	0
1/2" - 3/8"	5.2	1.2	0.2	4.8	1.1	0.2	4.4	1.0	0.2	0.7
3/8" - 4	40.6	4.3	0.1	39.8	4.2	0.1	36.3	2.5	0.1	34.0
4 - 10	25.3	4.7	0.2	25.0	4.7	0.2	25.7	3.1	0.1	30.0
+10	71.1	7.0	0.1	69.6	6.9	0.1	66.4	4.0	0.1	64.7
10 - 40	7.3	1.0	0.1	6.4	1.2	0.2	7.5	1.3	0.2	8.2
40 - 80	10.1	4.3	0.4	7.5	3.2	0.4	12.1	2.0	0.2	10.6
80 - 200	8.6	2.9	0.3	9.4	3.6	0.4	8.3	1.4	0.2	12.1
- 200	2.9	0.9	0.3	7.0	0.6	0.1	5.7	0.6	0.1	4.4

NOTE: STD. DEV. = Standard Deviation

$$\text{C.V.} = \text{Coefficient of Variation (\%)} = \frac{\text{STD. DEV.}}{\text{AVERAGE}}$$

Table 8. Basic results of wet versus dry sieving for Item 340 Type "D" hot-mix production from Ivan Dement, Inc., drum-dryer plant.

PRODUCER: IVAN DEMENT INC.
TYPE PLANT: DRUM-DRYER
DAYS SAMPLED: 11
NO. OF SAMPLES: 35
HOT-MIX DESIGN TYPE "D" ITEM 340
AGGREGATES:
1. Wayland College "D" Rock, 55%
2. Wayland College Screenings, 30%
3. Big Blue Creek Sand. 15%

DISTRICT: 4
COUNTY: MOORE
HIGHWAY: U.S. 287
PROJECT: C66-4-32
CONTROL: 66-4-32

AVERAGES OF 35 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	* % BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0	0	0	0	0	0	0	0	0	0
1/2" - 3/8"	1.8	0.8	0.4	1.5	0.7	0.5	1.9	1.4	0.7	3.0
3/8" - 4	40.5	3.6	0.1	39.2	3.7	0.1	35.1	5.9	0.2	38.8
4 - 10	24.2	1.7	0.1	23.0	1.6	0.1	25.7	5.1	0.2	22.6
+ 10	66.5	2.8	0.0	63.7	3.2	0.1	62.7	7.9	0.1	64.4
10 - 40	16.4	1.7	0.1	14.2	1.5	0.1	16.8	4.1	0.2	16.2
40 - 80	12.4	1.3	0.1	10.8	1.1	0.1	11.5	3.4	0.3	13.9
80 - 200	3.7	0.8	0.2	4.2	0.7	0.2	5.1	0.6	0.1	3.6
- 200	1.0	0.3	0.3	7.1	1.4	0.2	4.0	2.0	0.5	1.9

NOTE: STD. DEV. = Standard Deviation C.V. = Coefficient of Variation $= \frac{\text{STD. DEV.}}{\text{AVERAGE}}$

* Only 7 extractions were tested.

Table 9. Basic results of wet versus dry sieving for Item 340 Type "D" hot-mix from Gaylord Construction Co. weigh-batch plant

PRODUCER: GAYLORD CONSTRUCTION CO.
TYPE PLANT: WEIGH-BATCH
DAY SAMPLES:
NO. OF SAMPLES: 10
HOT-MIX DESIGN: TYPE "D" ITEM 340
AGGREGATES:

1. McCrorey Pit Large, 41.7%
2. McCrorey Pit Intermediate, 20.0%
3. McCrorey Pit Fines. 38.3%

DISTRICT: 11
COUNTY: SAN JACINTO
PROJECT: CRP 177-2-38
CONTROL: 177-2-38

AVERAGES FOR 10 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
1/2" - 3/8"	5.3	3.0	0.6	4.8	2.9	0.6	4.0	3.2	0.8	1.3
3/8" - 4	39.3	2.9	0.1	38.2	3.2	0.1	40.7	3.1	0.1	31.4
4 - 10	17.0	2.1	0.1	15.9	1.9	0.1	17.9	3.7	0.2	20.6
+ 10	61.6	1.2	0.0	58.9	2.0	0.0	62.6	1.3	0.0	53.3
10 - 40	14.3	3.8	0.3	11.2	2.8	0.3	12.7	4.2	0.3	15.8
40 - 80	16.3	2.2	0.1	16.1	1.5	0.1	15.8	2.2	0.1	18.0
80 - 200	5.8	1.5	0.3	6.7	1.9	0.3	7.3	2.3	0.3	9.7
PASS 200	2.0	0.5	0.3	7.1	1.9	0.3	1.6	1.1	0.7	3.2
TOTAL	100.0			100.0			100.0			

NOTE: STD. DEV. = Standard Deviation C.V. = Coefficient of Variation = $\frac{\text{STD. DEV.}}{\text{AVERAGE}}$

TABLE 10. Basic results of wet versus dry sieving for a total of 30 samples of Item 340 Type "D" hot-mix from the Downing Brothers, Inc. weigh-batch plant.

PRODUCER: DOWNING BROTHERS, INC. OF WACO, TEXAS
TYPE PLANT: WEIGH-BATCH
DAYS SAMPLED: 8-12-82 per 9-14-82, (10 days)
NO. OF SAMPLES: 30
HOT-MIX DESIGN: TYPE "D" SURFACE
AGGREGATES:

1. Crushed Tehuacana Limestone "D" Rock, 63%
2. Crushed Tehuacana Limestone Crusher Screenings, 23%
3. Coarse Field Sand, 10%
4. Eine Field Sand. 4%

DISTRICT: 9
COUNTY: McCLENNAN
PROJECT: CRP 258-6-26 ETC
CONTROL: 258-6-26 ETC

AVERAGES FOR 30 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0	0	0	0	0	0	0	0	0	0
1/2" - 3/8"	0.8	0.6	0.8	0.7	0.5	0.7	1.1	0.5	0.4	2.5
3/8" - 4	41.1	3.8	0.1	40.6	3.8	0.1	38.8	2.7	0.1	38.3
4 - 10	23.9	2.8	0.1	23.8	2.7	0.1	23.8	2.4	0.1	22.7
+10	65.8	2.3	0.0	65.1	2.2	0.0	63.7	1.5	0.0	63.5
10 - 40	9.1	2.0	0.2	9.1	1.8	0.2	9.7	1.3	0.1	11.4
40 - 80	12.6	1.9	0.2	12.0	1.5	0.1	13.9	2.0	0.1	13.1
80 - 200	9.5	1.5	0.2	9.2	1.1	0.1	8.9	1.1	0.1	8.5
- 200	2.9	1.1	0.4	4.6	0.9	0.2	3.8	0.4	0.1	3.5

NOTE: STD. DEV. = Standard Deviation

C.V. = Coefficient of Variation (%) = $\frac{\text{STD. DEV.}}{\text{AVERAGE}}$

Table 10A. Basic results of wet versus dry sieving for first subtotal of 15 samples of Item 340 Type "D" hot-mix from the Downing Brothers, Inc. weigh-batch plant.

PRODUCER: DOWNING BROTHERS, INC. OF WACO, TEXAS
TYPE PLANT: WEIGH-BATCH
DAYS SAMPLED: 8-12-82 per 8-24-82, (5 days)
NO. OF SAMPLES: 15
HOT-MIX DESIGN: TYPE "D" SURFACE
AGGREGATES:

1. Crushed Tehuacana Limestone "D" Rock, 63%
2. Crushed Tehuacana Limestone Crusher Screenings, 23%
3. Coarse Field Sand, 10%
4. Fine Field Sand. 4%

DISTRICT: 9
COUNTY: McCLENNAN
PROJECT: CRP 258-6-26
CONTROL: 258-6-26

AVERAGES FOR 15 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0	0		0	0		0	0		0
1/2" - 3/8"	0.9	0.7	0.8	0.8	0.5	0.6	1.0	0.4	0.4	2.5
3/8" - 4	42.9	3.7	0.1	42.3	3.6	0.1	38.2	2.9	0.1	38.3
4 - 10	23.3	3.2	0.1	23.3	3.1	0.1	24.5	2.5	0.1	22.7
+10	67.1	1.7	0.0	66.4	1.7	0.0	63.7	1.2	0.0	63.5
10 - 40	8.1	2.1	0.3	8.1	1.5	0.2	9.3	1.1	0.1	11.4
40 - 80	12.1	1.9	0.2	11.5	1.0	0.1	13.6	1.0	0.1	13.1
80 - 200	10.1	1.1	0.1	9.7	1.0	0.1	9.6	0.8	0.1	8.5
- 200	2.5	0.6	0.2	4.4	0.6	0.1	3.8	0.3	0.3	3.5

NOTE: STD. DEV. = Standard Deviation

C.V. = Coefficient of Variation (%) = $\frac{\text{STD. DEV.}}{\text{AVERAGE}}$

Table 10B. Basic results of wet versus dry sieving for second subtotal of 15 samples of Item 340 Type "D" hot-mix from the Downing Brothers, Inc. weigh-batch plant.

PRODUCER: DOWNING BROTHERS, INC. OF WACO, TEXAS
TYPE PLANT: WEIGH BATCH
DAYS SAMPLED: 9-7-82 per 9-14-82, (5 days)
NO. OF SAMPLES: 15
HOT-MIX DESIGN: TYPE "D" SURFACE
AGGREGATES:
1. Crushed Techuacana Limestone "D" Rock, 63%
2. Crushed Techuacana Limestone Crusher Screenings, 23%
3. Coarse Field Sand, 10%
4. Fine Field Sand. 4%

DISTRICT : 9
COUNTY: McCLENNAN and BOSQUE
HIGHWAY: Loop 340 and S.H. 6
PROJECT: CRP 258-9-77
CONTROL: 258-9-77

AVERAGES FOR 15 SAMPLES

PASS-RTD SIEVE SIZES	% BY DRY SIEVE	STD. DEV.	C.V.	% BY WET SIEVE	STD. DEV.	C.V.	% BY EXTRACTION	STD. DEV.	C.V.	DESIGN
5/8" - 1/2"	0	0		0	0		0	0		0
1/2" - 3/8"	0.7	0.5	0.7	0.6	0.5	0.8	1.1	0.5	0.5	2.5
3/8" - 4	39.4	3.2	0.1	38.9	3.3	0.1	39.5	2.3	0.1	38.3
4 - 10	24.5	2.2	0.1	24.3	2.2	0.1	23.0	2.2	0.1	22.7
+10	64.6	2.0	0.0	63.8	2.1	0.0	63.6	1.8	0.0	63.5
10 - 40	10.1	1.3	0.1	10.2	1.5	0.1	10.0	1.4	0.1	11.4
40 - 80	13.1	1.7	0.1	12.6	1.8	0.1	14.3	2.6	0.2	13.1
80 - 200	8.9	1.7	0.2	8.8	1.0	0.1	8.2	1.0	0.1	8.5
- 200	3.3	1.3	0.4	4.6	1.0	0.2	3.9	0.5	0.1	3.5

NOTE: STD. DEV. = Standard Deviation

C.V. = Coefficient of Variation (%) = $\frac{\text{STD. DEV.}}{\text{AVERAGE}}$

Table 11. Aggregate compositions of hot-mixes evaluated in sieving study.

Table Number	Hot-Mix Type	District; Producer; Plant Type	PERCENT COMPOSITION OF AGGREGATES				
			Limestone	Iron Ore	Weathered Siliceous Gravel	Siliceous Sand	Sandstone
1.	"D"	15 Vulcan Weigh-batch	73.5			26.5	
2.	"B"	15 Affiliated Drum-Dryer	77.9			22.1	
3.	"D"	15 Affiliated Drum-Dryer	75.0				25.0
4.	"D"	15 McDonough Weigh-batch	64.6			35.4	
5.	"D"	15 Affiliated Drum-Dryer	69.0			31.0	
6.	"D"	25 Gilvin-Terrell Drum-Dryer			100.0		
7.	"D"	17 Young Brothers Drum-Dryer	52.2			19.0	28.8

(Continued)

Table 11. (Continued) Aggregate compositions of hot-mixes evaluated in sieving study.

Table Number	Hot-Mix Type	District; Producer; Plant Type	PERCENT COMPOSITION OF AGGREGATES				
			Limestone	Iron Ore	Weathered Siliceous Gravel	Siliceous Sand	Sandstone
8.	"D"	4 Ivan-Dement Drum-Dryer	85.0			15.0	
9.	"D"	11 Gaylord Weigh-batch		100.0			
10, 10A & 10B	"D"	9 Downing Brothers Weigh-batch	86.0			14.0	

Tables 12 and 13. Net percent changes in material retained between sieves based on (a) dry to wet sieving and (b) dry to extraction sieving as taken from Tables 1 and 6, respectively.

Table 12. Vulcan Materials Type "D"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	0.0	0.0
1/2 - 3/8	-0.3	-2.0
3/8 - 4	+0.1	-0.4
4 - 8	0.0	+2.7
8 - 10	-0.2	+0.4
10 - 16	0.0	0.0
16 - 30	-0.1	+0.4
30 - 40	-0.1	-0.3
40 - 50	-0.2	-0.2
50 - 80	+0.1	-0.3
80 - 100	-0.7	-0.6
100 - 200	-0.3	-0.1
-200	+1.6	+0.3

Table 13. Gilvin-Terrell Contractors Type "D"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	0.0	0.0
1/2 - 3/8	-0.3	-1.9
3/8 - 4	-0.7	-4.5
4 - 8	-1.3	-1.0
8 - 10	+0.4	+0.2
10 - 16	-1.1	+0.5
16 - 30	-1.3	+0.8
30 - 40	+0.1	+0.1
40 - 50	-0.3	+0.2
50 - 80	-0.1	+0.4
80 - 100	+0.1	+0.4
100 - 200	0.0	+1.5
-200	+4.5	+3.3

Tables 14 and 15. Net percent changes in material retained between sieves based on (a) dry to wet sieving and (b) dry to extraction sieving as taken from Tables 5 and 2, respectively.

Table 14. Affiliated Aggregates Type "D" "Tight"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	-0.2	-0.2
1/2 - 3/8	-0.3	-0.4
3/8 - 4	-1.9	-2.0
4 - 8	-0.9	+2.6
8 - 10	+0.2	-0.8
10 - 16	-0.8	+0.3
16 - 30	-1.7	-1.0
30 - 40	+0.3	-0.9
40 - 50	-0.9	0.0
50 - 80	+0.9	+0.9
80 - 100	0.0	+0.5
100 - 200	+0.5	+0.4
-200	+5.0	+0.8

Table 15. Affiliated Aggregates Type "B"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	-0.1	-4.2
1/2 - 3/8	-0.5	-3.0
3/8 - 4	-0.6	+0.7
4 - 8	-0.3	+3.3
8 - 10	0.0	-0.1
10 - 16	-0.2	+0.7
16 - 30	0.0	+0.3
30 - 40	-0.4	-0.5
40 - 50	-1.1	-0.2
50 - 80	-0.4	+1.3
80 - 100	-0.2	+0.2
100 - 200	0.0	+0.3
-200	+3.8	+1.4

Tables 16 and 17. Net percent changes in material retained between sieves based on (a) dry to wet sieving and (b) dry to extraction sieving as taken from Tables 3 and 4, respectively.

Table 16. Affiliated Aggregates Type "D"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	-0.1	0.0
1/2 - 3/8	-0.4	-3.0
3/8 - 4	-0.2	-1.8
4 - 8	-0.2	+2.4
8 - 10	-0.2	+0.1
10 - 16	-0.3	+0.4
16 - 30	+0.1	+1.2
30 - 40	-1.1	-0.4
40 - 50	-1.0	-0.2
50 - 80	-0.3	-0.5
80 - 100	-0.3	0.0
100 - 200	+0.1	+0.2
-200	+3.6	+1.5

Table 17. McDonough Brothers Type "D"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	-0.1	-0.1
1/2 - 3/8	0.0	+0.5
3/8 - 4	-0.4	-3.0
4 - 8	+0.1	+1.0
8 - 10	-0.2	+0.1
10 - 16	+0.1	+0.7
16 - 30	-0.1	+0.5
30 - 40	-0.2	0.0
40 - 50	0.0	+0.4
50 - 80	-0.5	-0.7
80 - 100	+0.1	0.0
100 - 200	-0.2	-0.2
-200	+1.5	+1.0

Tables 18-21. Net percent changes in material retained between sieves based on (a) dry to wet sieving and (b) dry to extraction sieving as taken from Tables 7, 8, 9 and 10, respectively.

Table 18. Younq Brothers Type "D"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	0	0
1/2 - 3/8	-0.4	-0.8
3/8 - 4	-0.8	-4.3
4 - 10	-0.3	+0.4
10 - 40	-0.9	+0.2
40 - 80	-2.6*	+2.0
80 - 200	+0.8	-0.3
-200	+4.1*	+2.8

Table 19. Ivan Dement Type "D"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	0	0
1/2 - 3/8	-0.3	+0.1
3/8 - 4	-1.3	-5.4
4 - 10	-1.2	+1.5
10 - 40	-2.2*	+0.4
40 - 80	-1.6	-0.9
80 - 200	+0.5	+1.4
-200	+6.1*	+3.0

Table 20. Gaylord Construction Type "D"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	0	0
1/2 - 3/8	-0.5	-1.3
3/8 - 4	-1.1	+1.4
4 - 10	-1.1	+0.9
10 - 40	-3.1*	-1.6
40 - 80	-0.2	-0.5
80 - 200	+0.9	+1.5
-200	+5.1*	-0.4

Table 21. Downing Brothers Type "D"

Screen Size Interval	Dry to Wet	Dry to Extraction
5/8 - 1/2	0	0
1/2 - 3/8	-0.1	+0.3
3/8 - 4	-0.5	-2.3
4 - 10	-0.1	-0.1
10 - 40	0.0	+0.6
40 - 80	-0.6	+1.3
80 - 200	-0.3	-0.6
-200	+1.7	+0.9

Table 22. Average net difference in percent retained on No. 10 sieve (2.00 mm) versus design by method of sieving for both types of hot-mix plants.

Plant Type (Table Number)	Average Change by Sieving Method		
	Dry	Wet	Extraction
WB (1)	5.6	5.2	6.3
DD (2)	-3.8	-5.3	-7.1
DD (3)	-2.5	-3.6	-4.8
WB (4)	1.2	0.6	-0.3
DD (5)	5.3	2.2	4.5
DD (6)	1.3	-0.6	-5.9
DD (7)	6.4	4.9	1.7
DD (8)	2.1	-0.7	-1.7
WB (9)	8.3	5.6	9.3
WB (10)	2.3	1.6	0.2
Average	2.6	1.0	0.2
S.D.	3.9	3.7	5.4
Range	-3.8 to 8.3	-5.3 to 5.6	-7.1 to 9.3

WB = Weigh-batch

DD = Drum-dryer

Table 23. Average net difference in percent retained on the No. 10 sieve (2.00 mm) versus design by method of sieving for six drum-dryer plant produced hot-mixes.

Table Number	Average Change by Sieving Method		
	Dry	Wet	Extraction
5	5.3	2.2	4.5
2	-3.8	-5.3	-7.1
3	-2.5	-3.6	-4.8
6	1.3	0.6	-5.9
7	6,4	4,9	1.7
8	2.1	-0.7	-1.7
Average	1.5	-0.6	-2.2
S.D.	4.1	3.7	4.6
Range	-3.8 to 6.4	-5.3 to 4.9	-7.1 to 4.5

Table 24. Average net difference in percent retained on the No. 10 sieve (2.00 mm) versus design by method of sieving for four weigh-batch plant produced hot-mixes.

Table Number	Average Change by Sieving Method		
	Dry	Wet	Extraction
4	1.2	0.6	-0.3
1	5.6	5.2	6.3
9	8.3	5.6	9.3
10	2.3	1.6	0.2
Average	4.4	3.3	3.9
S.D.	3.2	2.5	4.7
Range	1.2 to 8.3	0.6 to 5.6	-0.3 to 9.3

Table 25. Average net difference in percent retained on No. 200 sieve (75 μm) versus design by method of sieving and by hot-mix plant studied.

Plant Type (Table Number)	Average Change by Sieving Method		
	Dry	Wet	Extraction
WB (1)	-1.1	0.5	-0.8
DD (2)	-1.5	2.3	-0.1
DD (3)	-2.3	1.3	-0.8
WB (4)	-0.1	1.4	0.9
DD (5)	-1.8	3.2	-1.0
DD (6)	-1.1	3.4	2.2
DD (7)	-1.5	2.6	1.3
DD (8)	-0.9	5.2	2.1
WB (9)	-1.2	3.9	-1.6
WB (10)	-0.6	1.1	0.3
Average	-1.2	2.5	0.3
S.D.	0.6	1.5	1.3
Range	-2.3 to -0.1	0.5 to 5.2	-1.6 to 2.2

WB = Weigh-batch

DD = Drum-dryer

Table 26. Average net difference in percent passing No. 200 sieve (75 μm) versus design by method of sieving for six drum-dryer plant hot-mixes produced.

Table Number	Average Change by Sieving Method		
	Dry	Wet	Extraction
5	-1.8	3.2	-1.0
2	-1.5	2.3	-0.1
3	-2.3	1.3	-0.8
6	-1.1	3.4	2.2
7	-1.5	2.6	1.3
8	-0.9	5.2	2.1
Average	-1.5	3.0	0.6
S.D.	0.5	1.3	1.4
Range	-2.3 to -0.9	1.3 to 5.2	-1.0 to 2.2

Table 27. Average net difference in percent passing No. 200 sieve (75 m) versus design by method of sieving for four weigh-batch plant produced hot-mixes.

Table Number	Average Change by Sieving Method		
	Dry	Wet	Extraction
4	-0.1	1.4	0.9
1	-1.1	0.5	-0.8
9	-1.2	3.9	-1.6
10	-0.6	1.1	0.3
Average	-0.8	1.7	-0.3
S.D.	0.5	1.5	1.1
Range	-0.1 to 1.2	0.5 to 3.9	-1.6 to 0.9

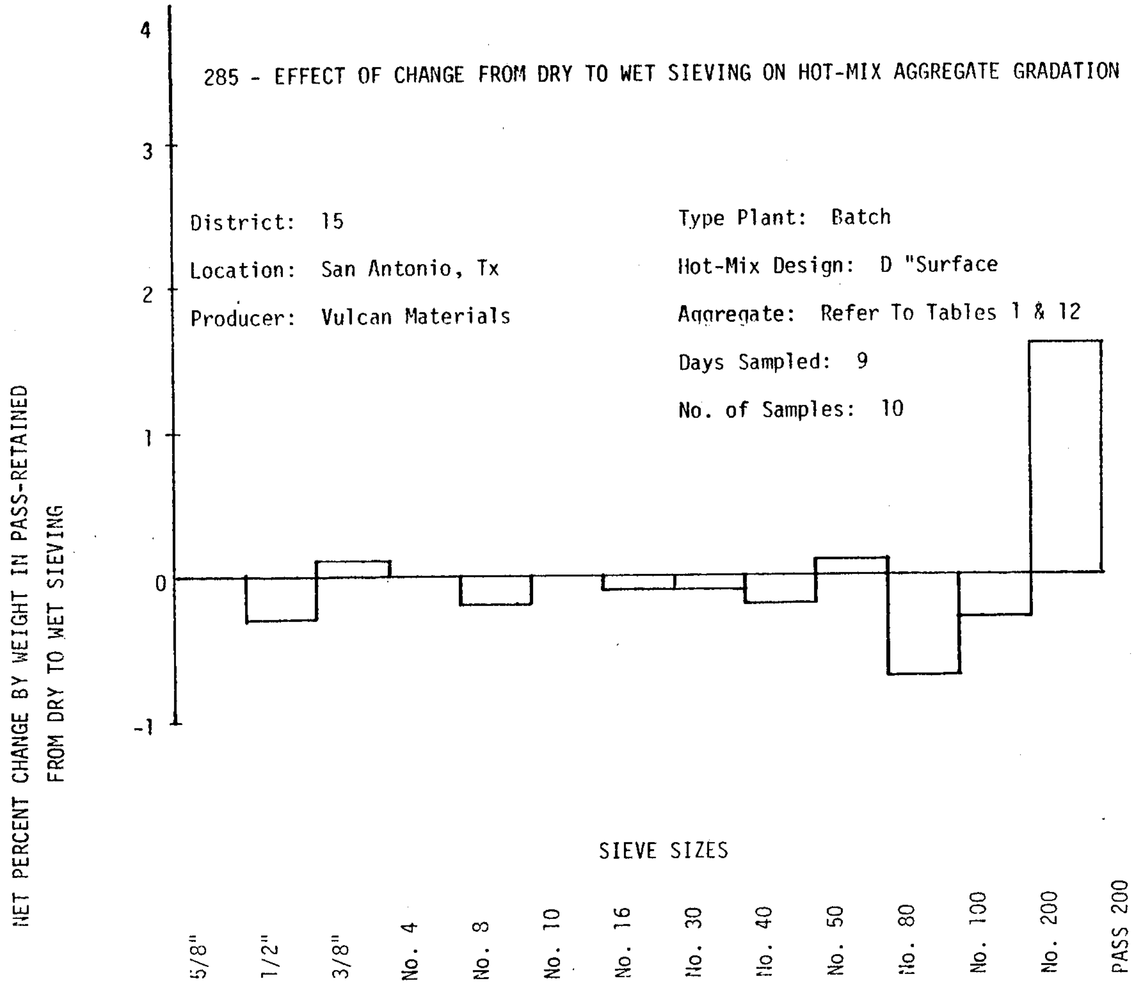

Figure 1. Average effects of changing from dry to wet sieving on Vulcan Materials Item 340 Type "D" hot-mix aggregate gradations.

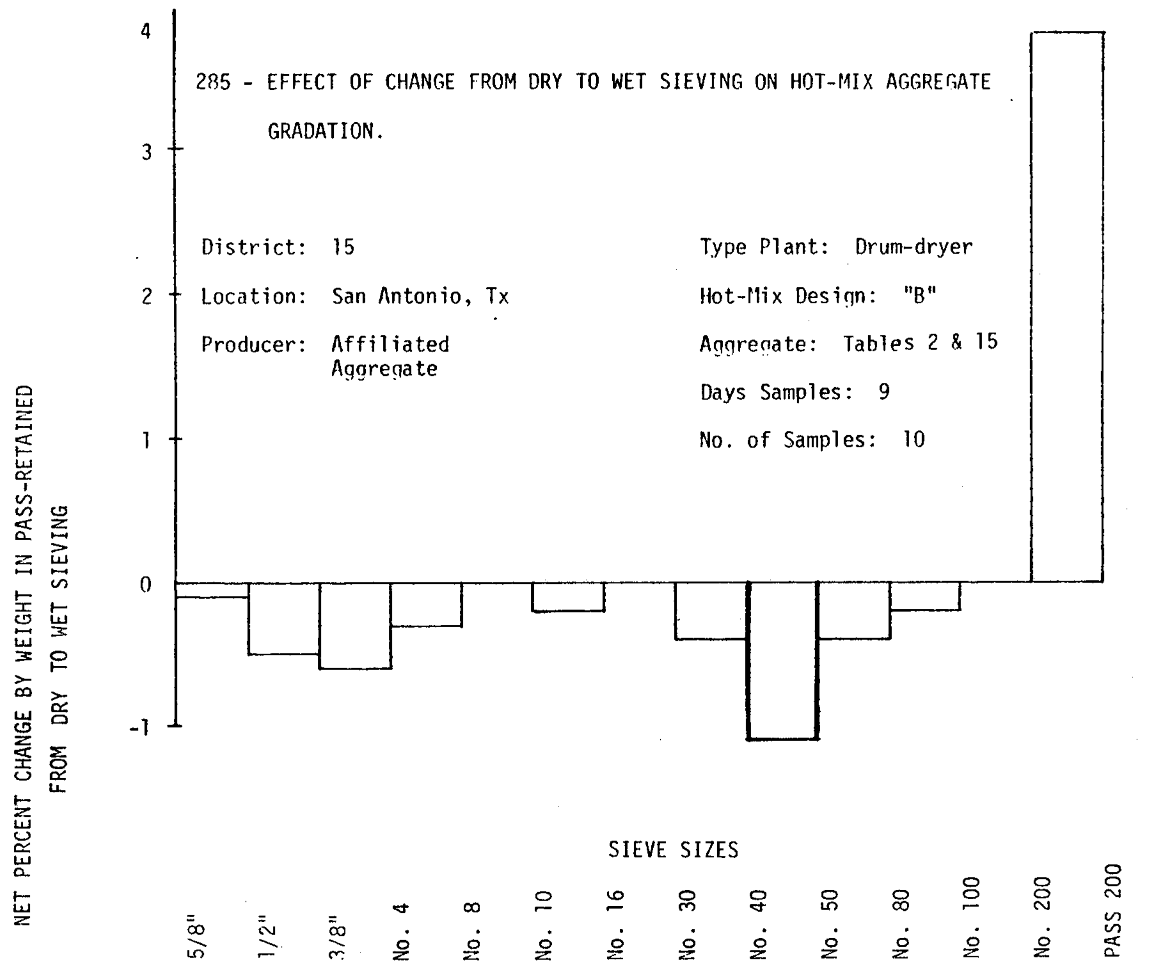

Figure 2. Average effects of changing from dry to wet sieving on Affiliated Aggregates Item 340 Type "B" hot-mix aggregate gradations.

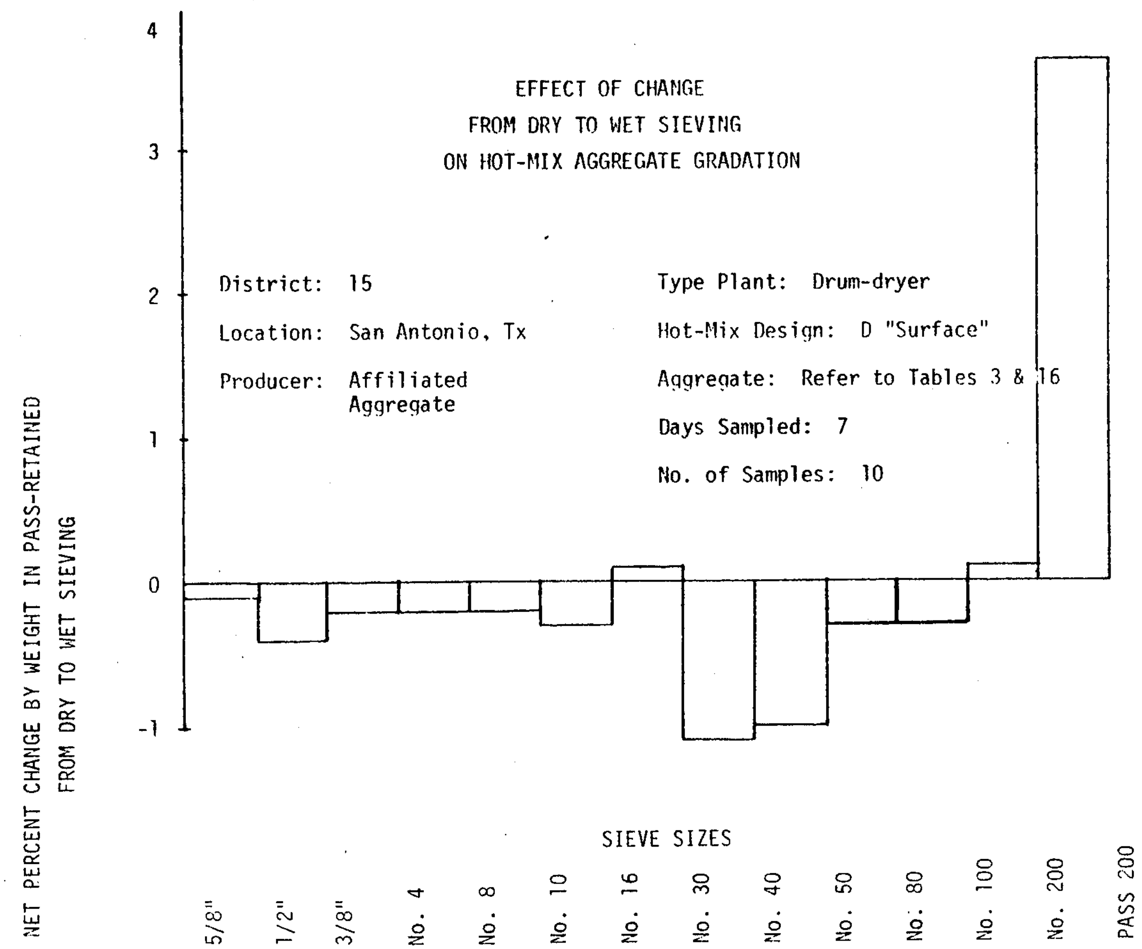

Figure 3. Average effects of changing from dry to wet sieving on Affiliated Aggregates Item 340 Type "D" "Surface" hot-mix aggregate gradations.

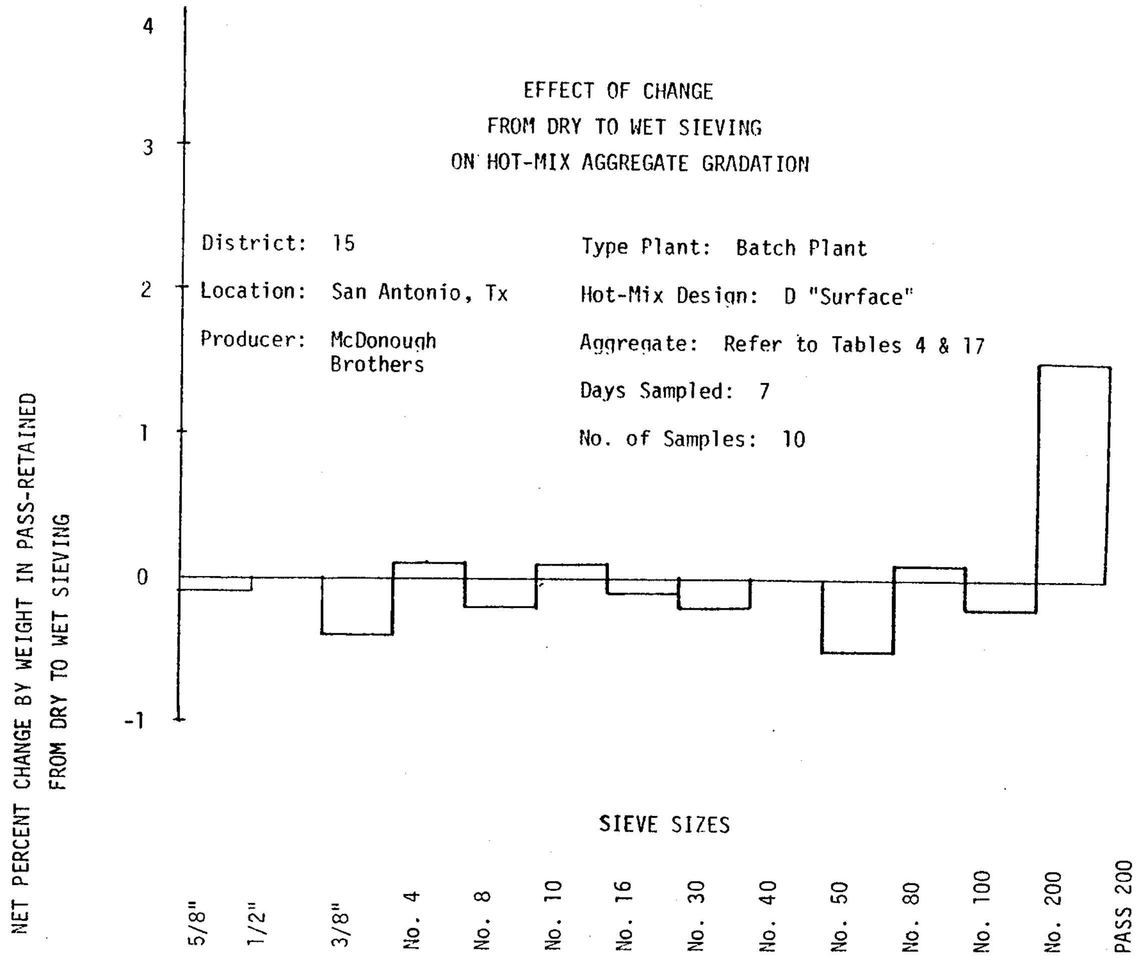

Figure 4. Average effects of changing from dry to wet sieving on McDonough Brothers Item 340 Type "D" "Surface" hot-mix aggregate gradations.

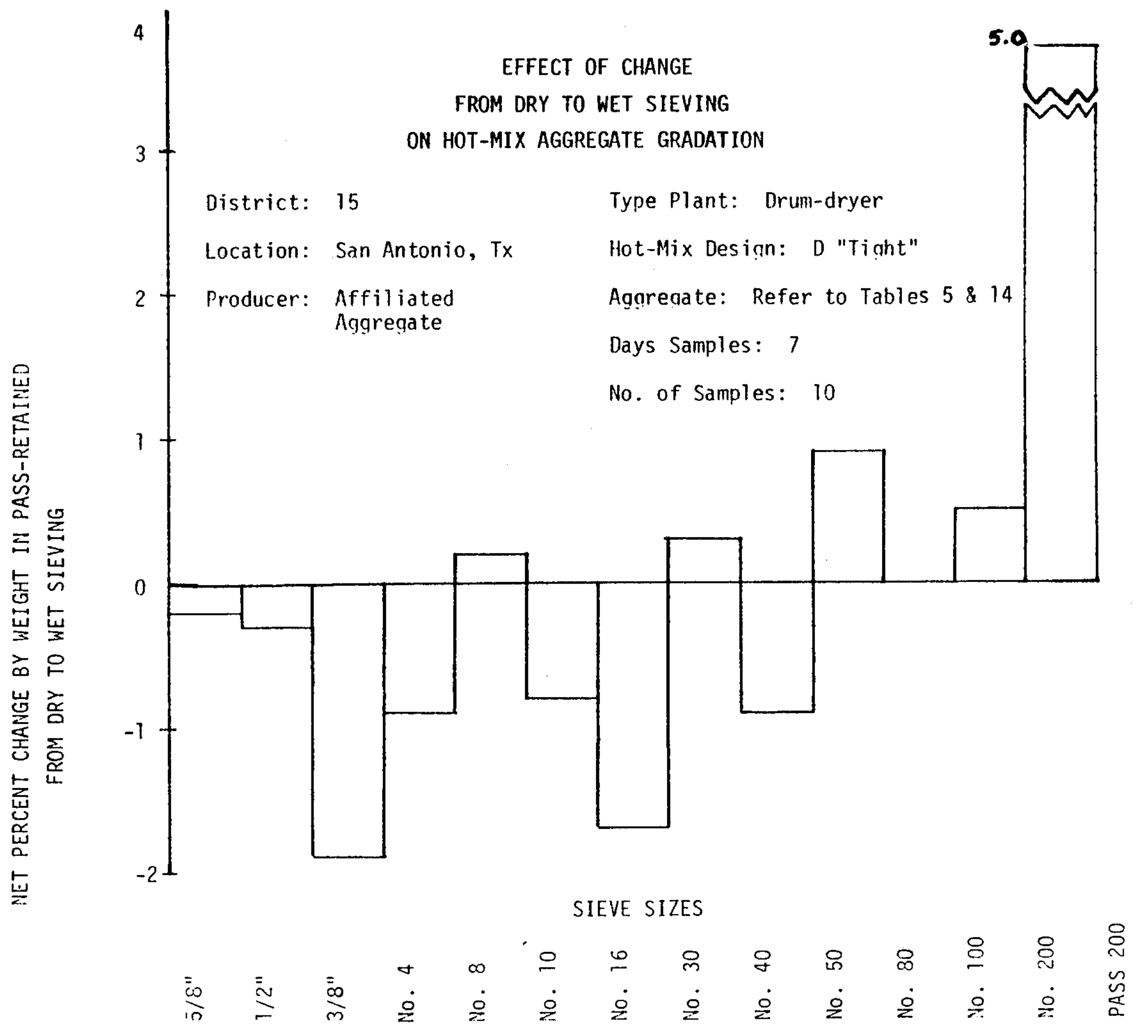

Figure 5. Average effects of changing from dry to wet sieving on Affiliated Aggregates Item 340 Type "D" "Tight" hot-mix aggregate gradations.

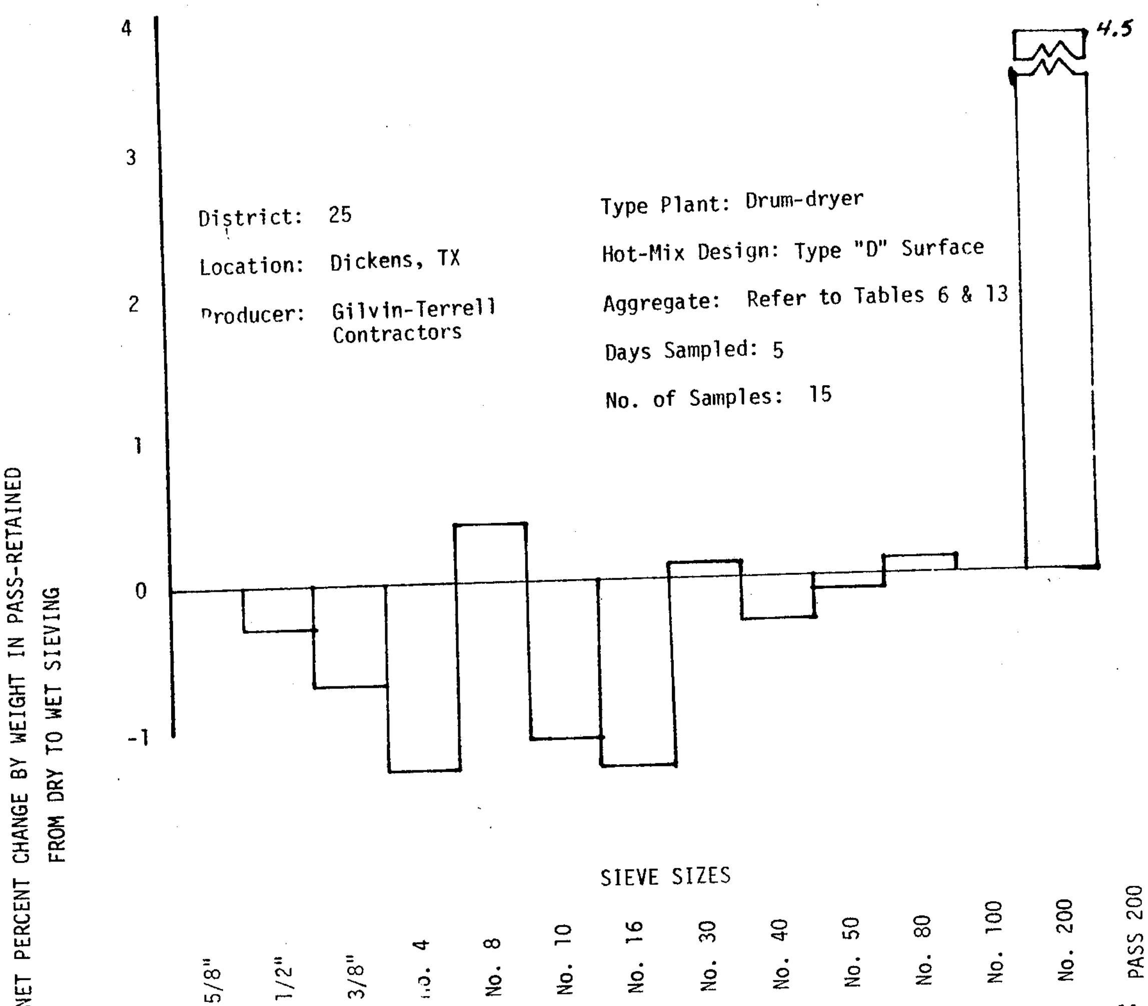

Figure 6. Average effects of changing from ary to wet sieving on Gilvin-Terrell Contractors Item 340 Type "D" "Surface" hot-mix aggregate gradations.

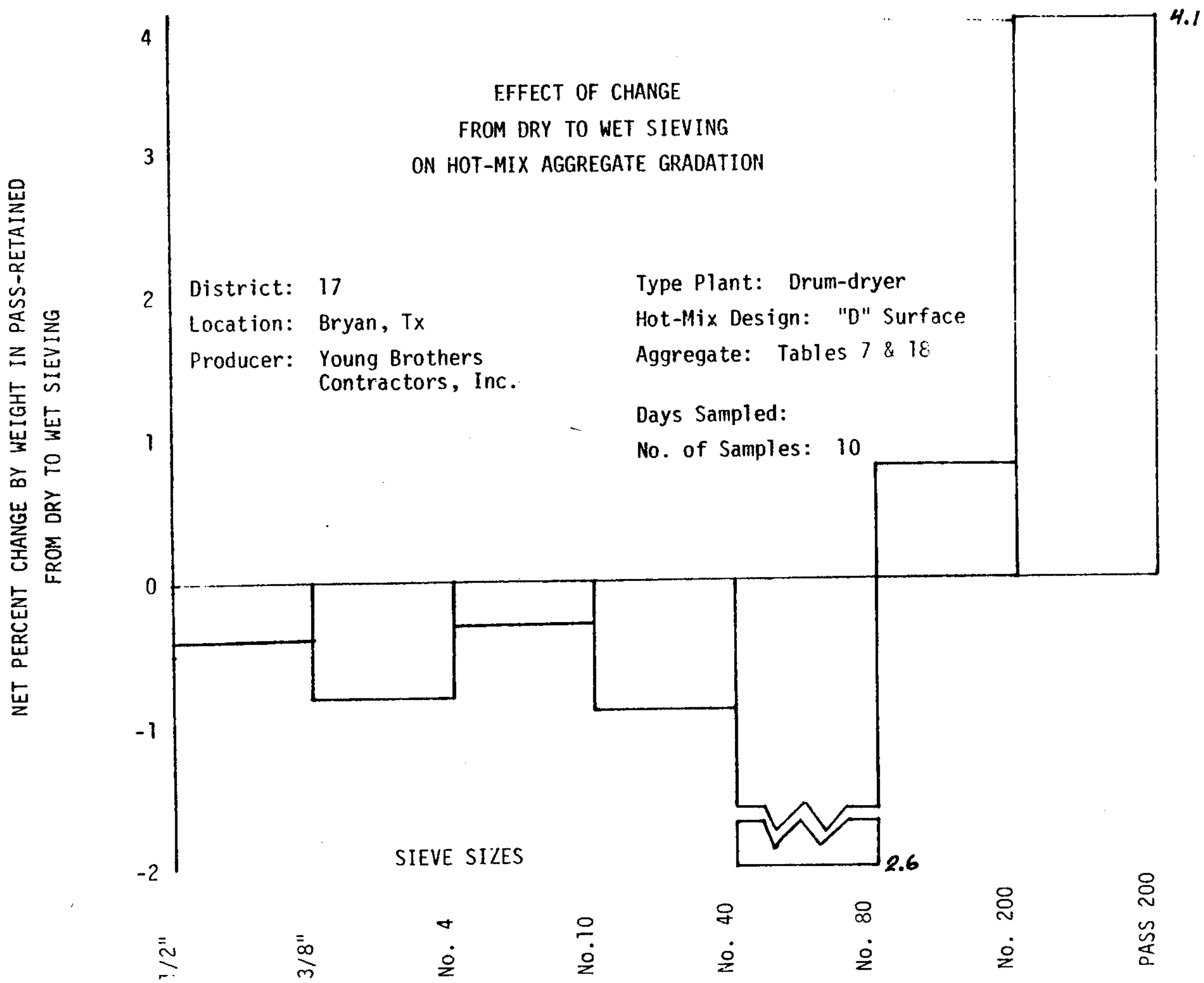

Figure 7. Average effects of changing from dry to wet sieving on Young Brothers, Contractors, Item 340 Type "D" "Surface" hot-mix aggregate gradations.

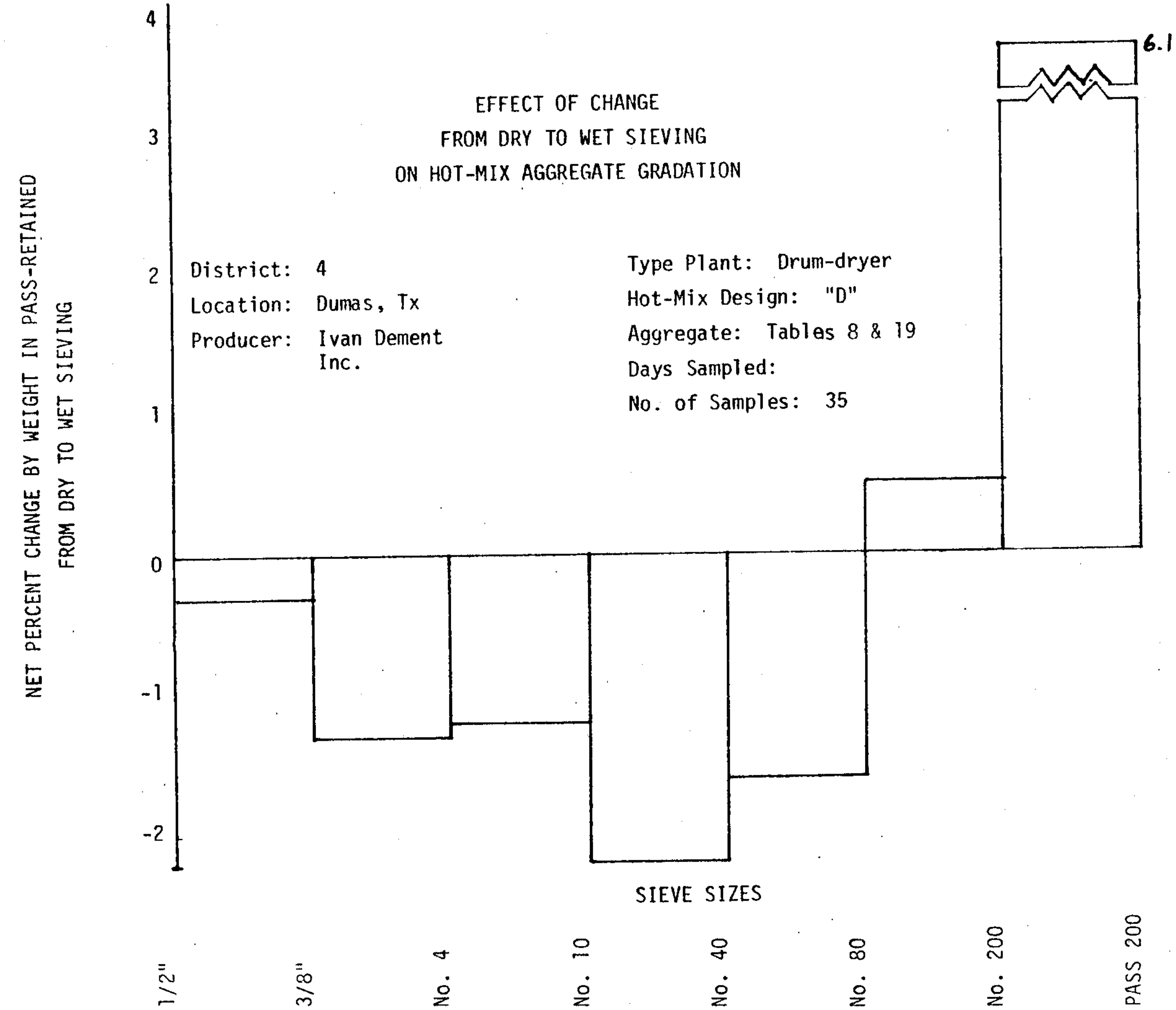

Figure 8. Average effects of changing from dry to wet sieving on Ivan Dement Item 340 Type "D" hot-mix aggregate gradations.

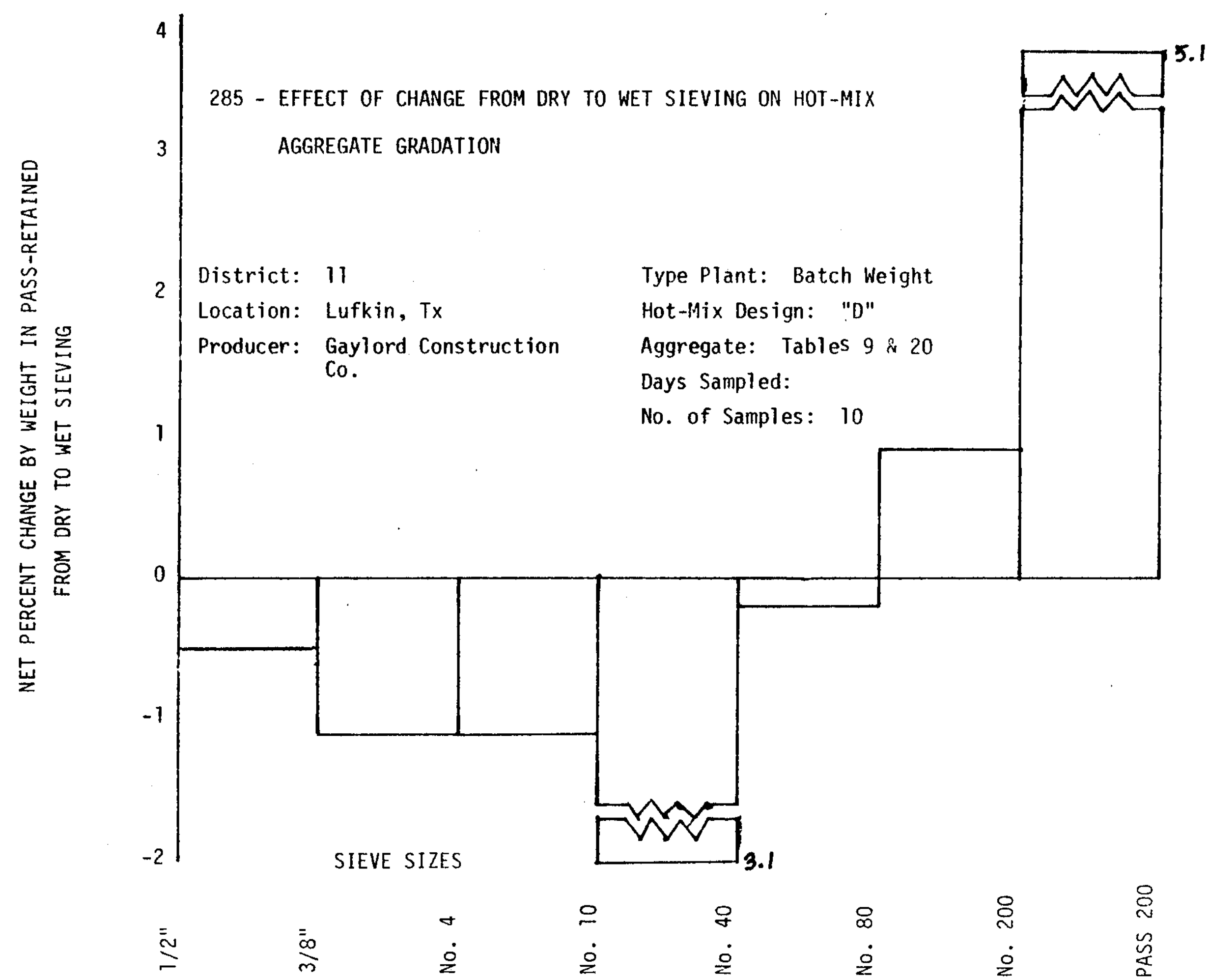

Figure 9. Average effects of changing from dry to wet sieving on Gaylord Construction Company Item 340 Type "D" hot-mix aggregate gradations.

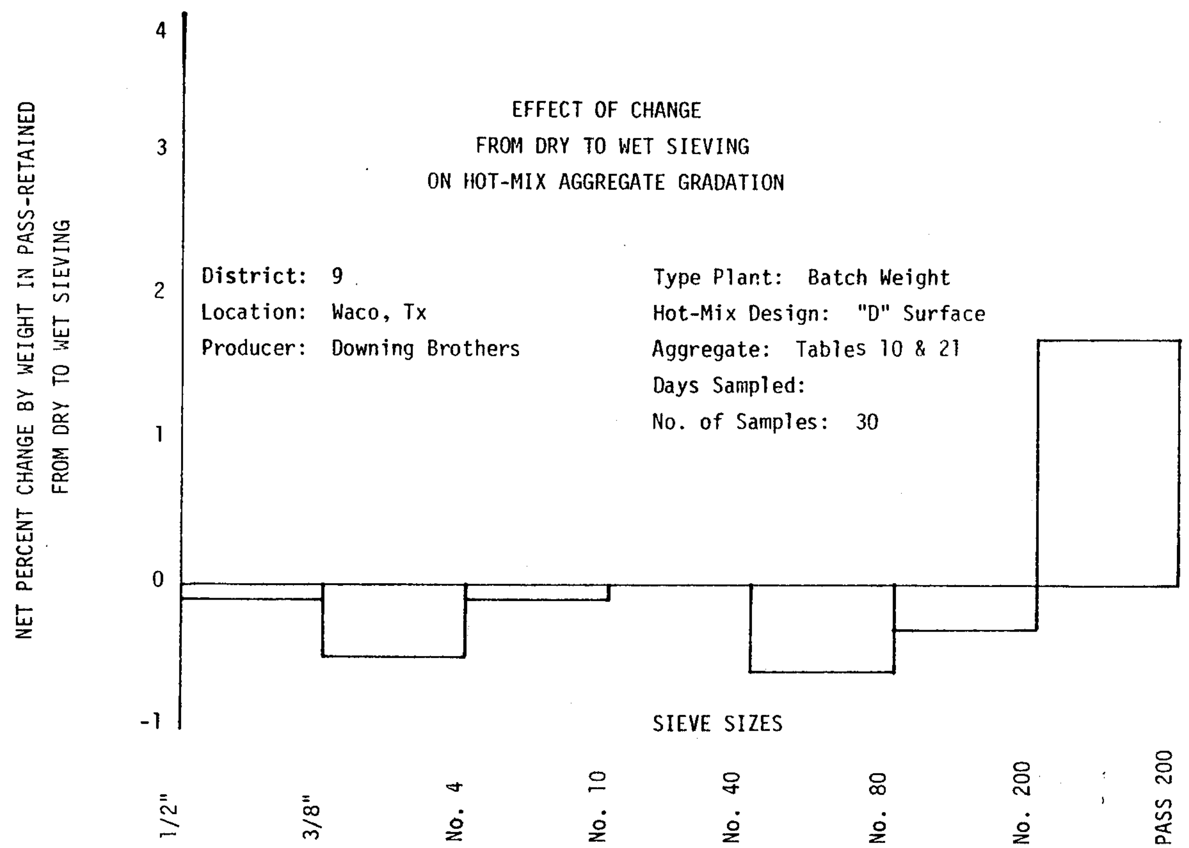

Figure 10. Average effects of changing from dry to wet sieving on Downing Brothers Item 340 Type "D" "Surface" hot-mix aggregate gradations.

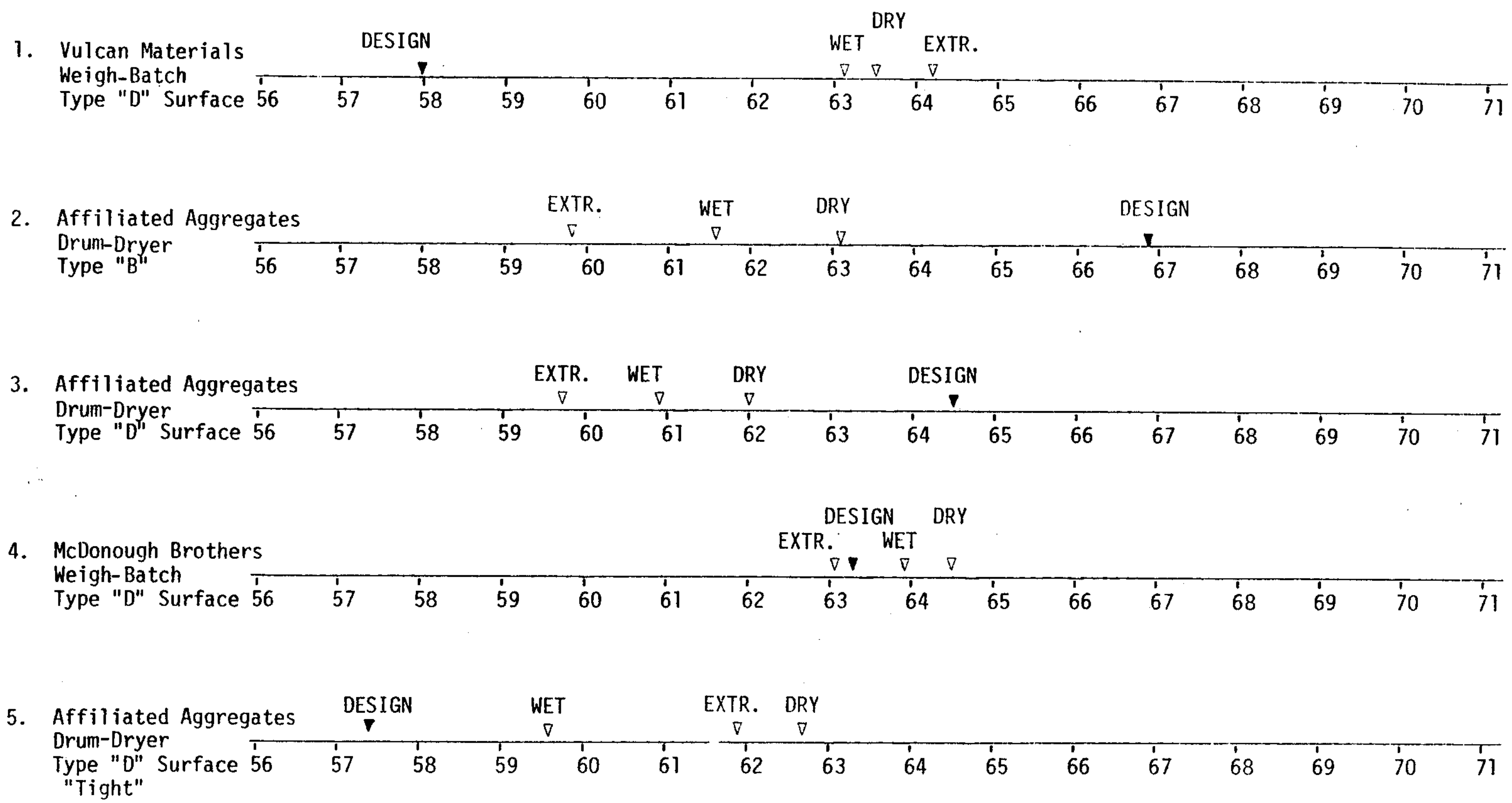

Figure 11. Relative locations of weight percents of aggregate retained on the No. 10 (2.00 mm) sieve versus design by sieving method and by plant produced hot-mix.

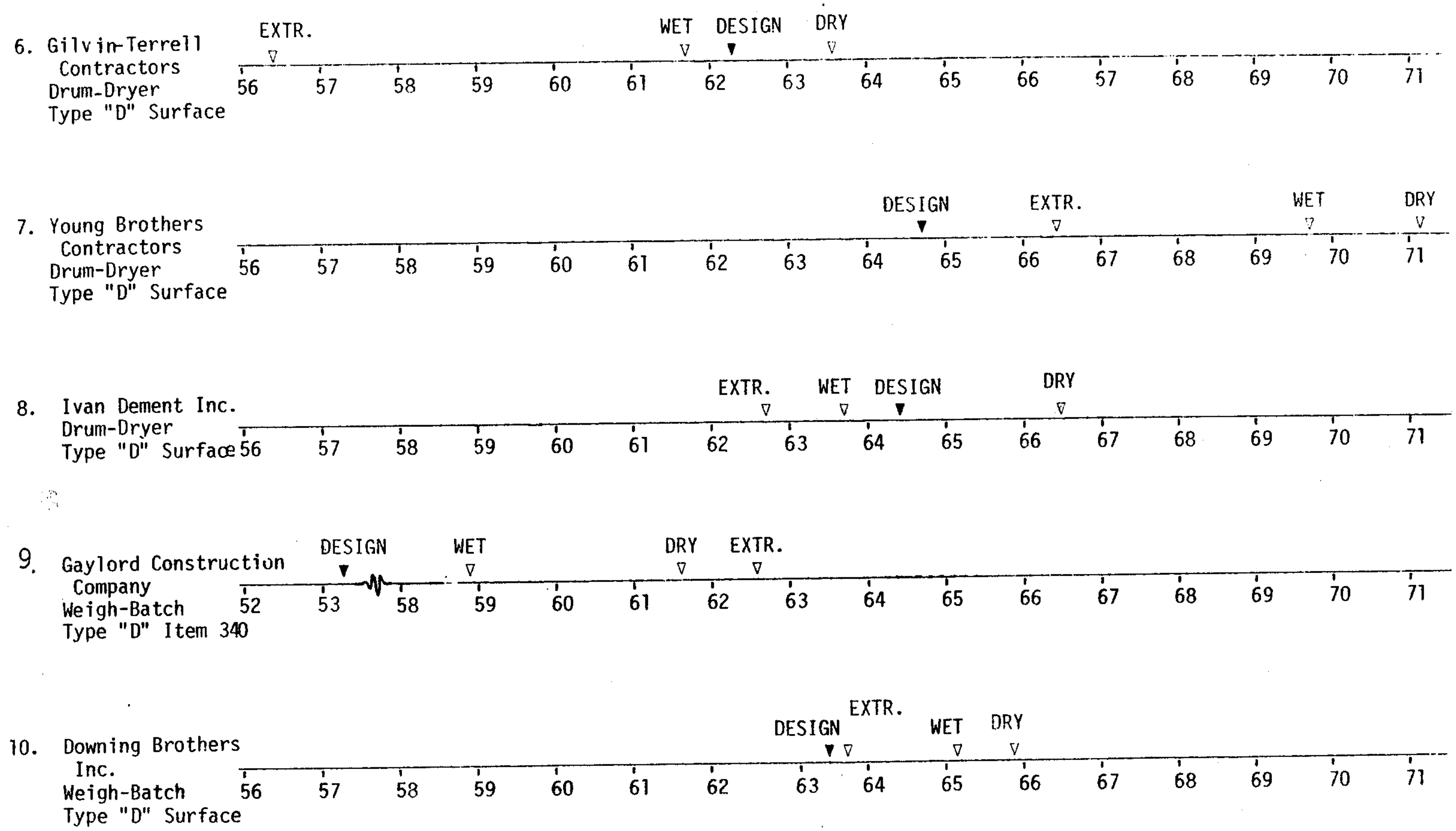

Figure 11. (Continued) Relative locations of weight percents of aggregate retained on the No. 10 sieve (2.00 mm) sieve versus design by sieving method and by plant produced hot-mix.

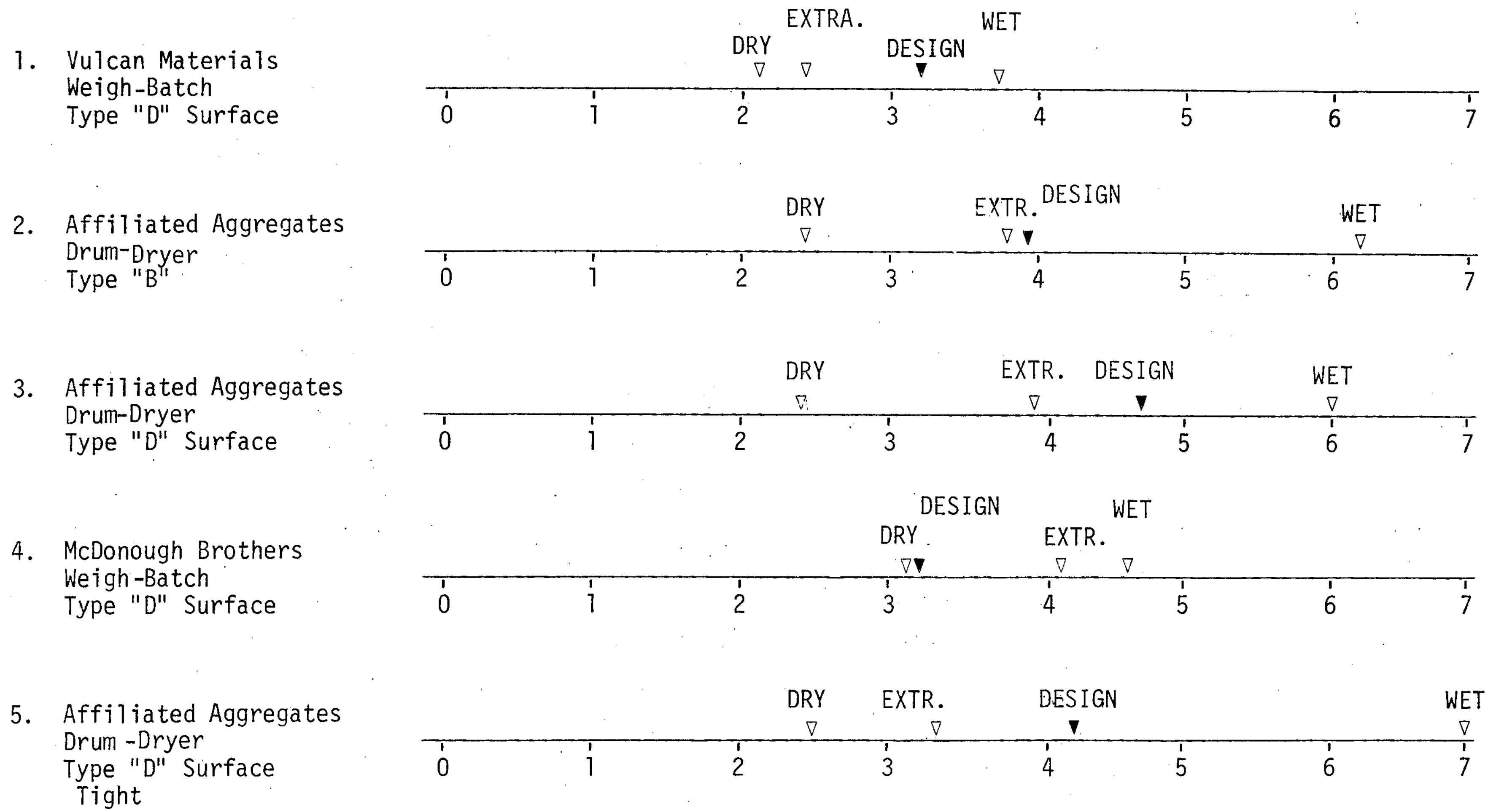

Figure 12. Relative locations of weight percents of aggregate passing the No. 200 (75 um) sieve versus design by sieving method and by plant produced not-mix.

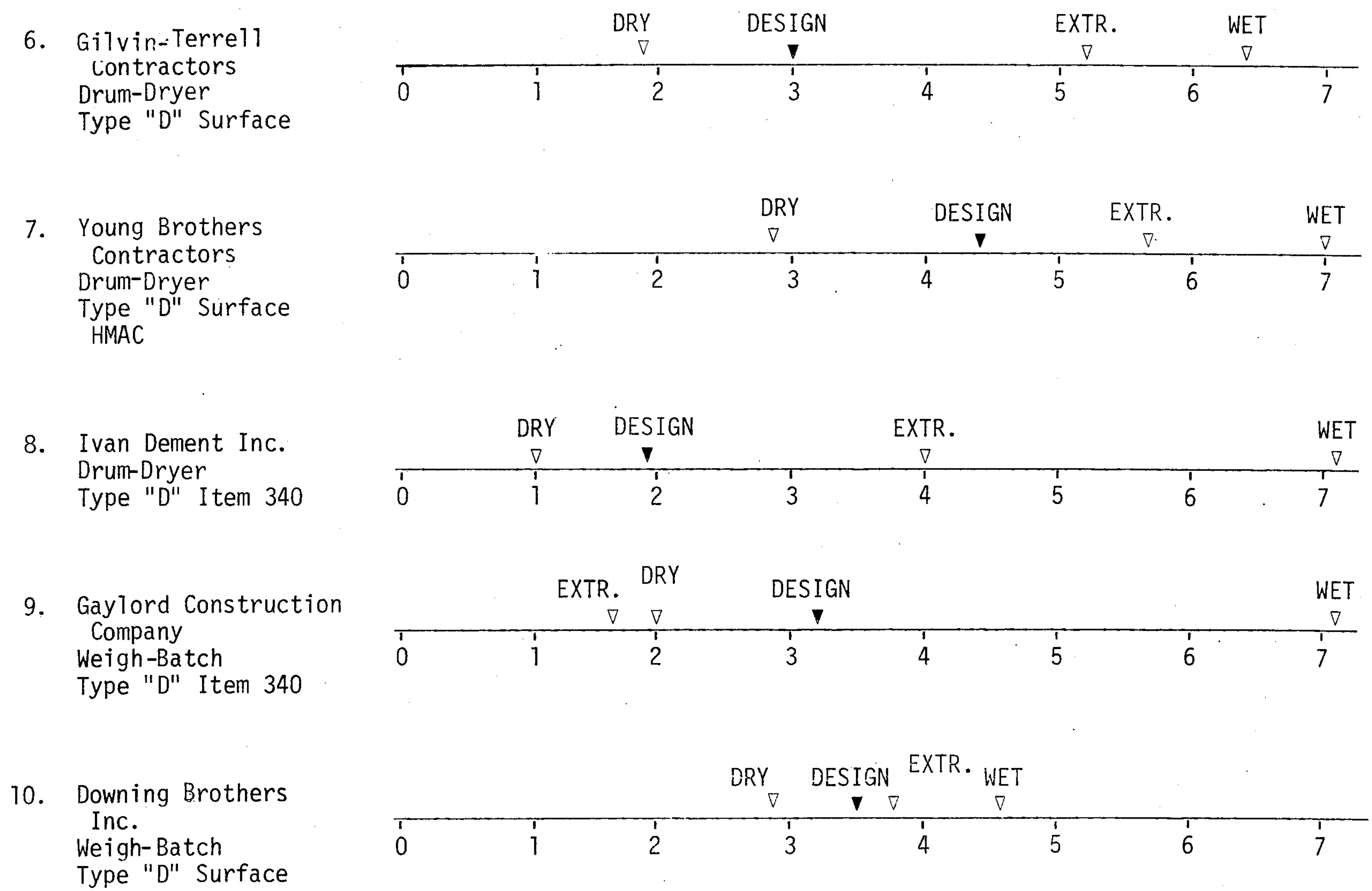

Figure 12. (Continued) Relative locations of weight percents of aggregate passing the No. 200 (75 μm) sieve versus design by sieving method and by plant produced hot-mix.

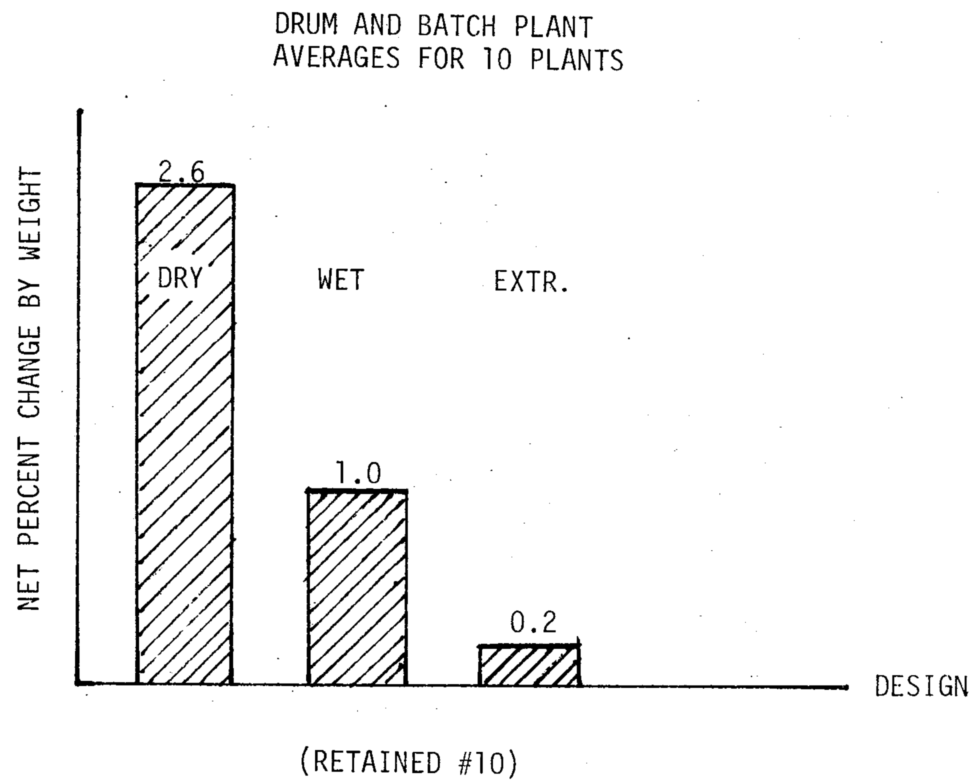

Figure 13. Average net differences from design in percents by weight of aggregates retained on the No 10 (3.00 mm) sieve by sieving method for all plant produced hot-mixes studied.

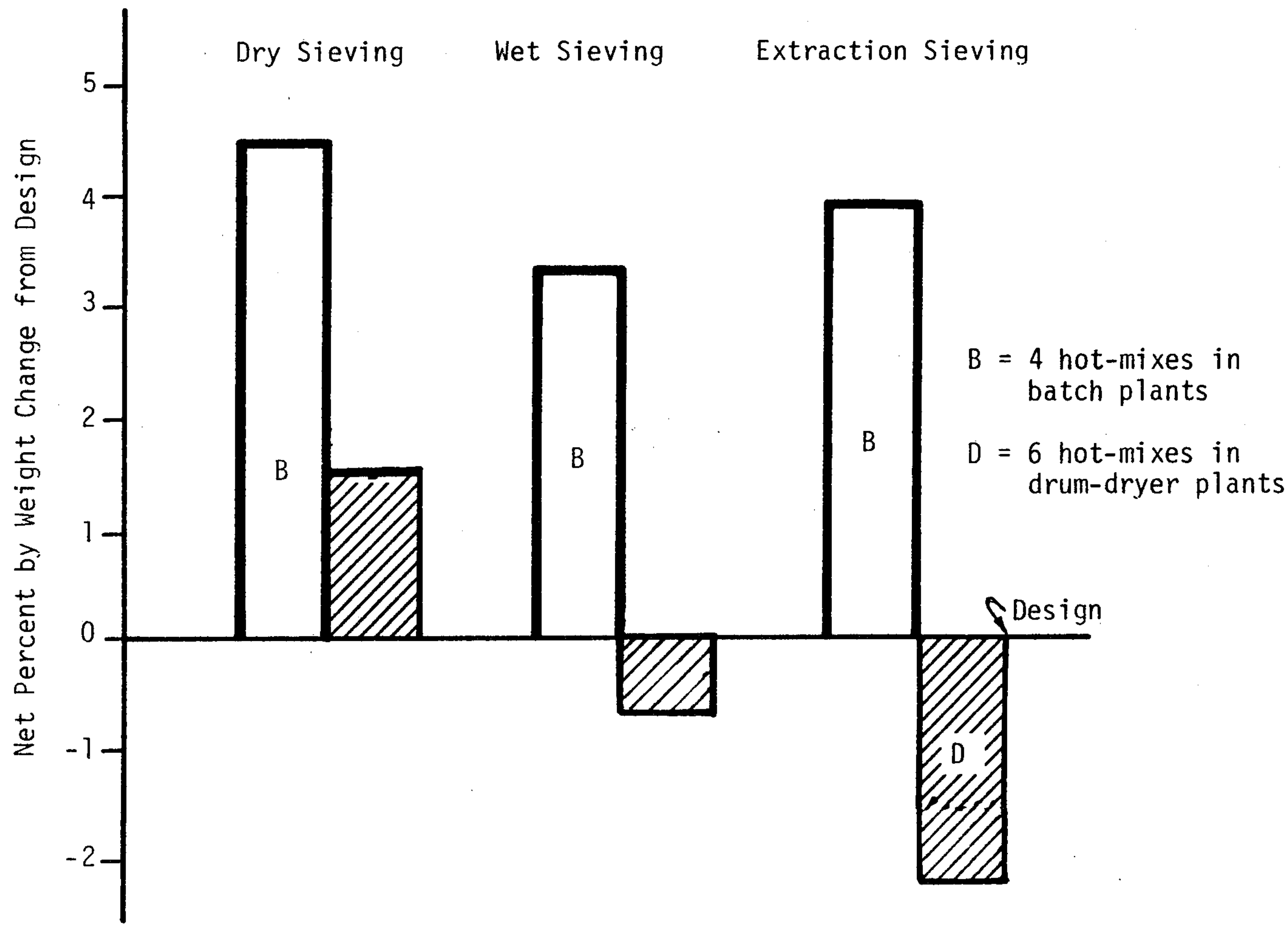

Figure 14. Average net differences from design in percents by weight of aggregates retained on the No. 10 (2.00 mm) sieve based on both sieving method and plant type.

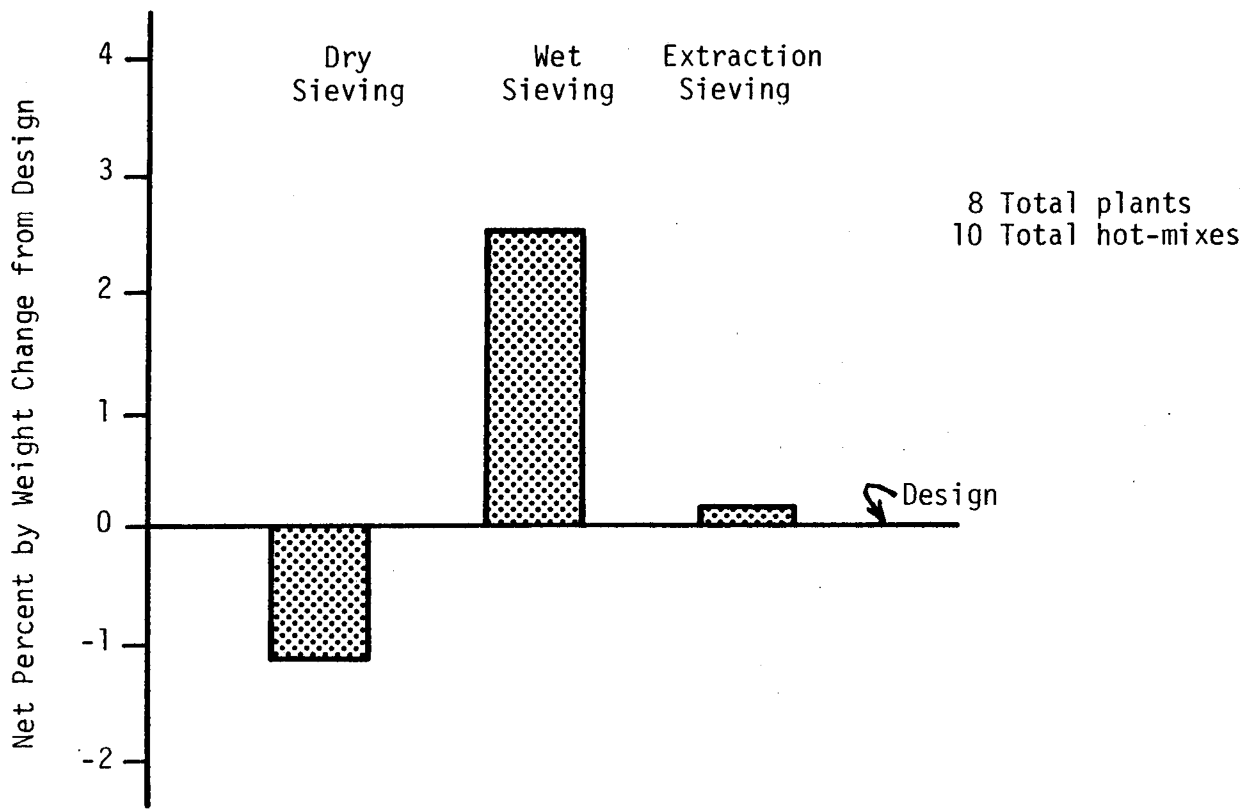

Figure 15. Average net differences from design in percents by weight of aggregates passing the No. 200 (75 μm) sieve by sieving method for all plant produced hot-mixes studied.

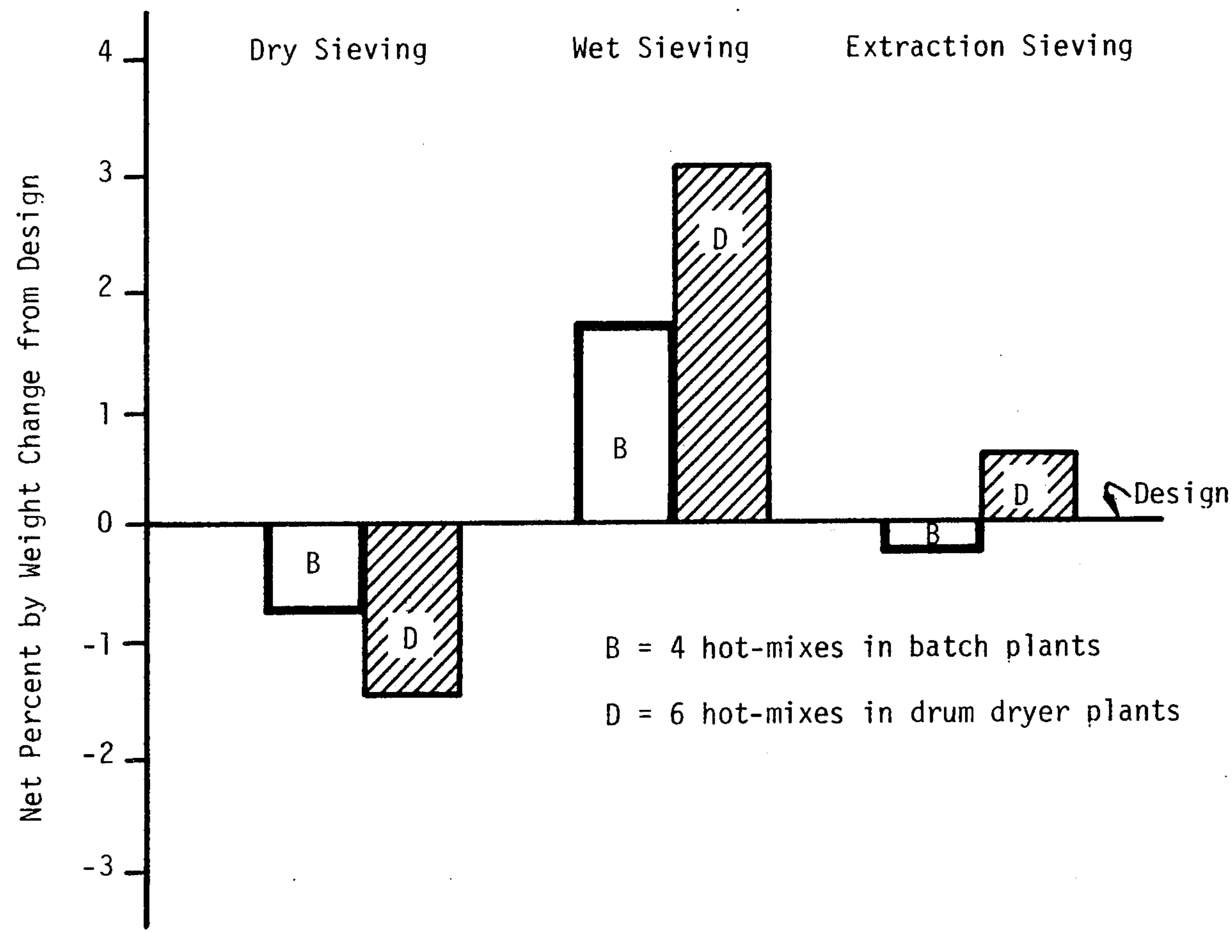

Figure 16. Average net differences from design in percents by weight of aggregates passing the No. 200 (75 μm) sieve based on both sieving method and plant type.

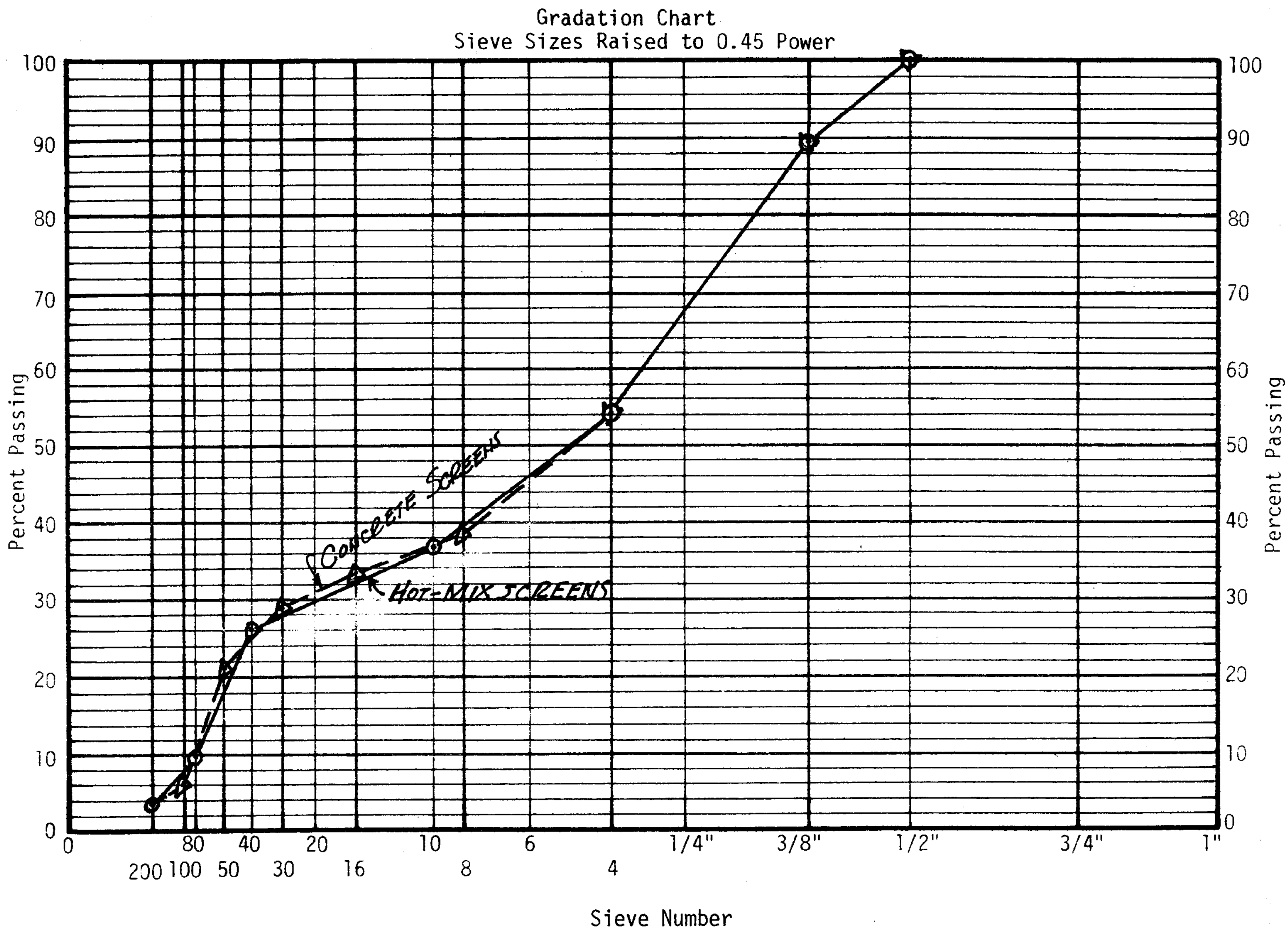

Figure 17. A comparison of the average results of using hot-mix sieves versus concrete sieves for wet sieving of Vulcan Materials aggregates from weigh-batch plant production, as taken from Table 1.

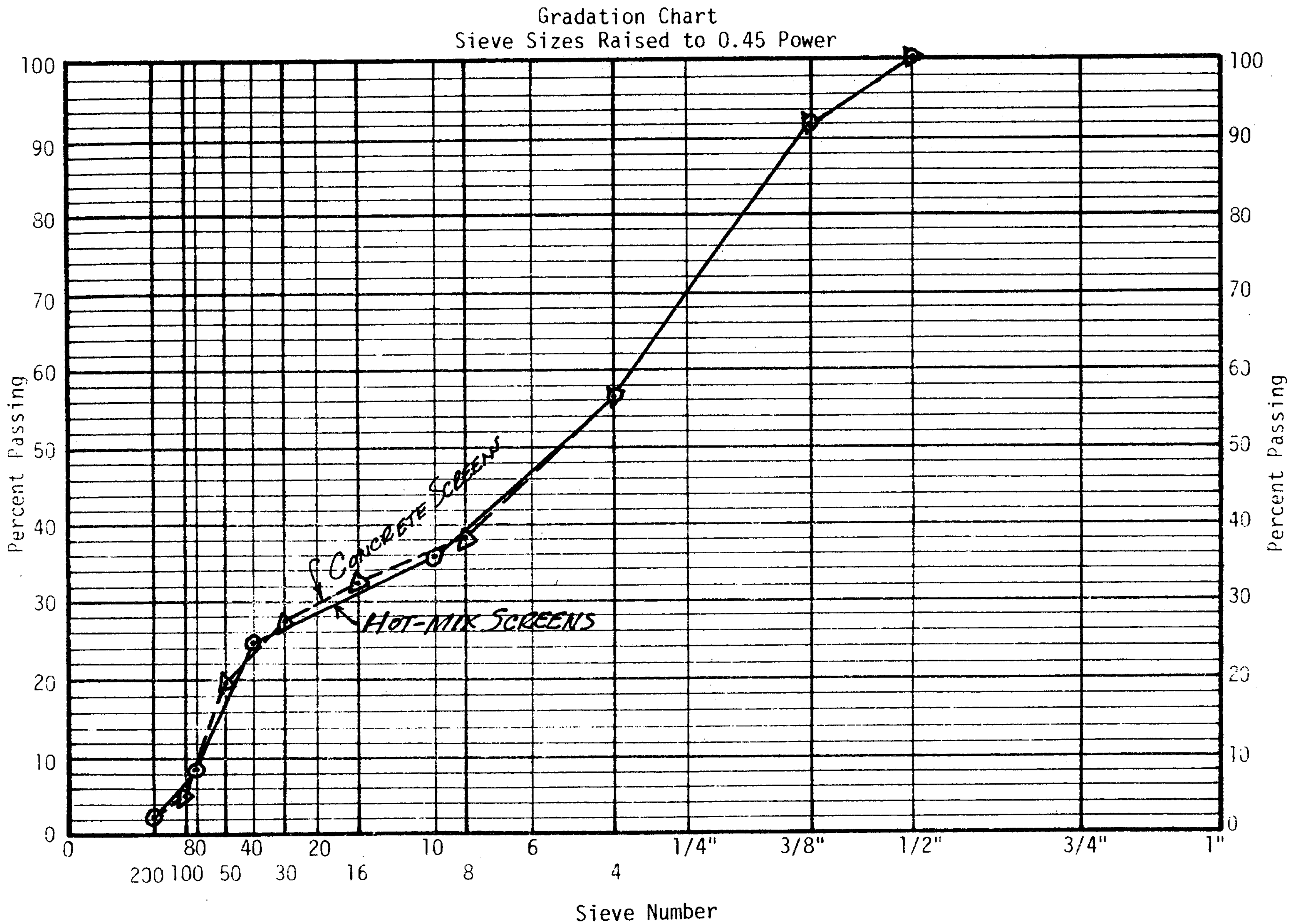

Figure 18. A comparison of the average results of using hot-mix sieves versus concrete sieves for extraction sieving of Vulcan Materials aggregates from weigh-batch plant production, as taken from Table 1.

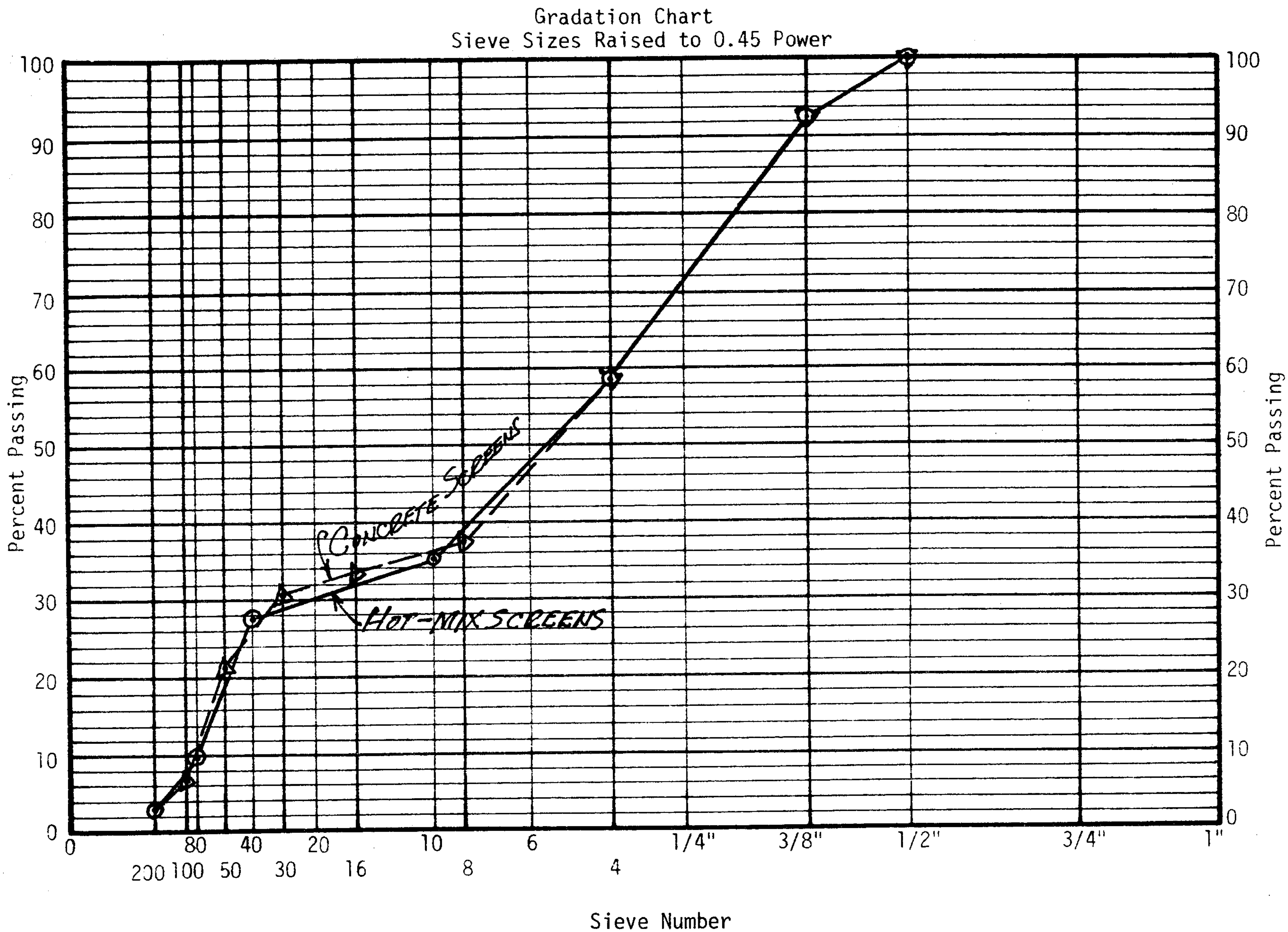

Figure 19. A comparison of the average results of using hot-mix sieves versus concrete sieves for dry sieving of McDonough Brothers aggregates from weigh-batch plant production, as taken from Table 4.

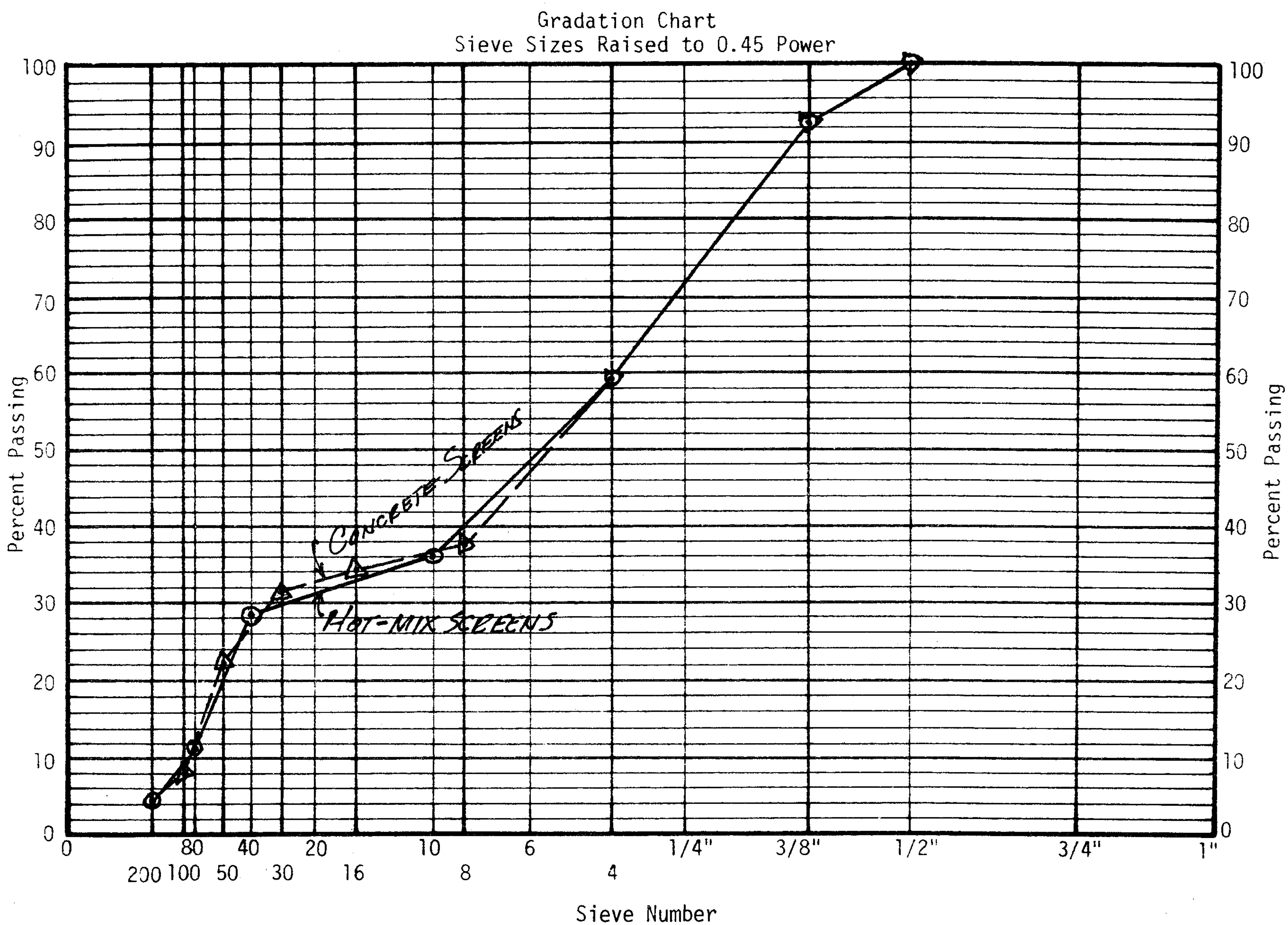

Figure 20. A comparison of the average results of using hot-mix sieves versus concrete sieves for wet sieving of McDonough Brothers aggregates from weigh-batch plant production, as taken from Table 4.

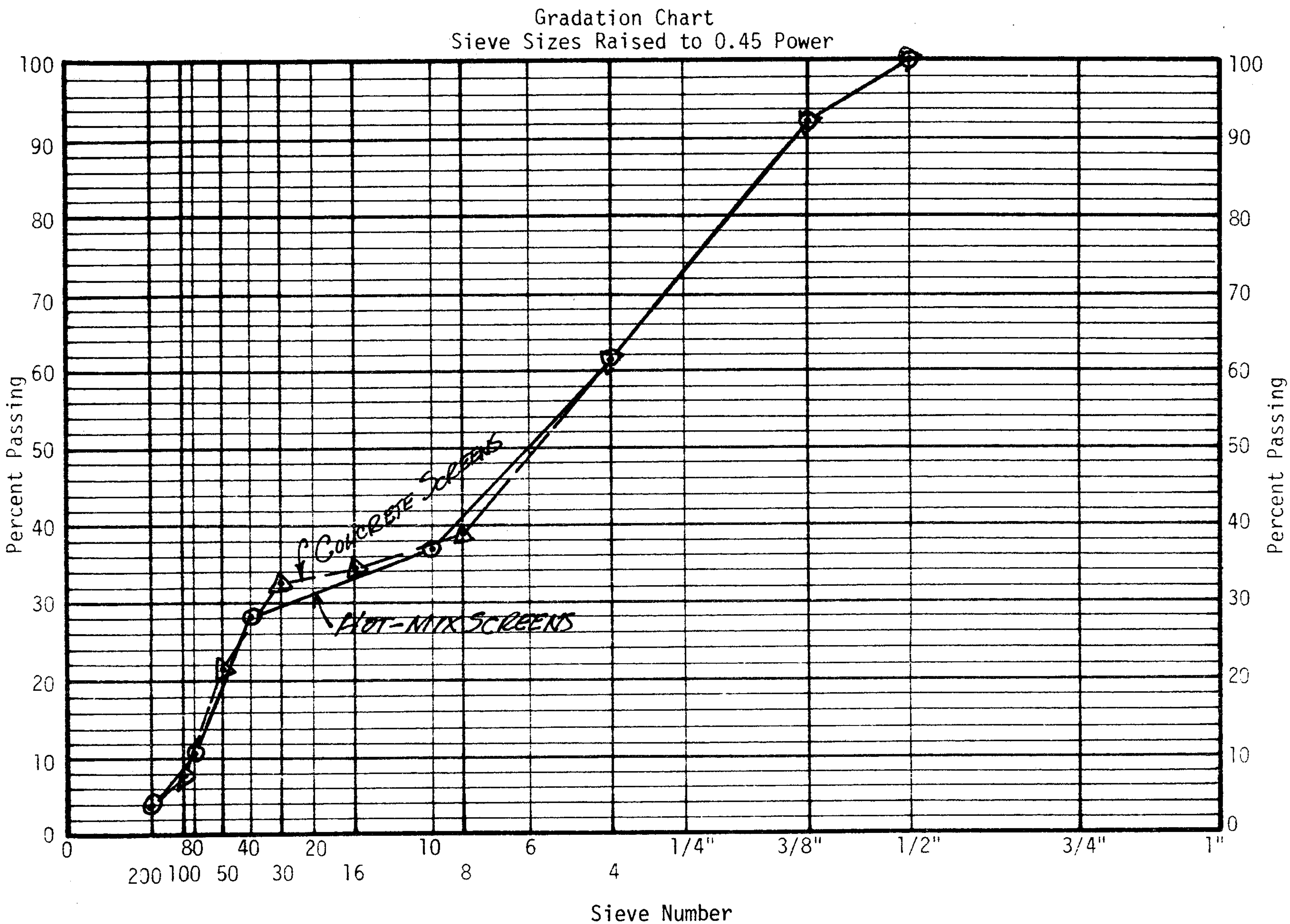

Figure 21. A comparison of the average results of using hot-mix sieves versus concrete sieves for extraction sieving of McDonough Brothers aggregates from weigh-batch plant production, as taken from Table 4.

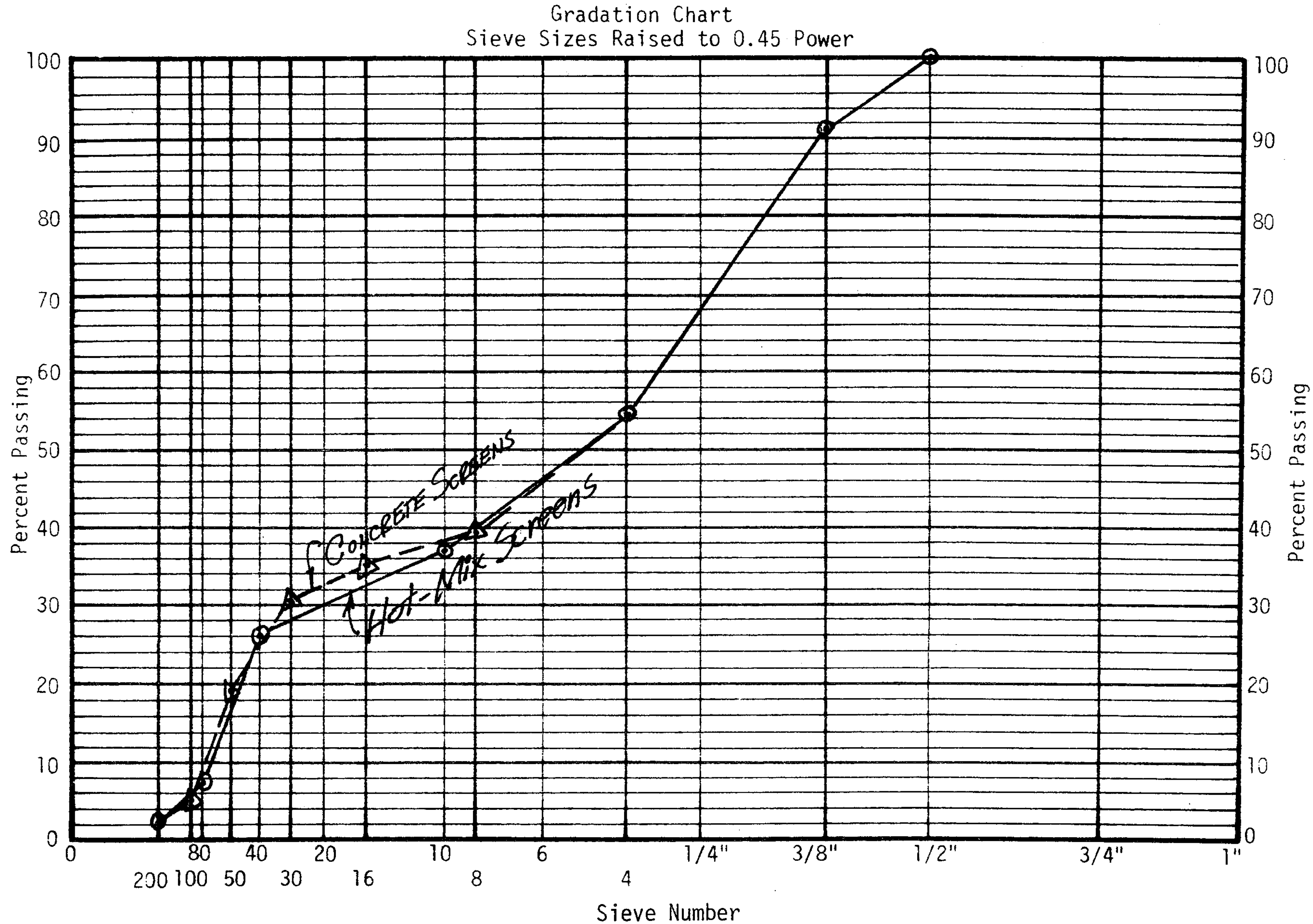

Figure. 22. A comparison of the average results of using hot-mix sieves versus concrete sieves for dry sieving of Affiliated Aggregates aggregates from drum-dryer plant production, as taken from Table 5.

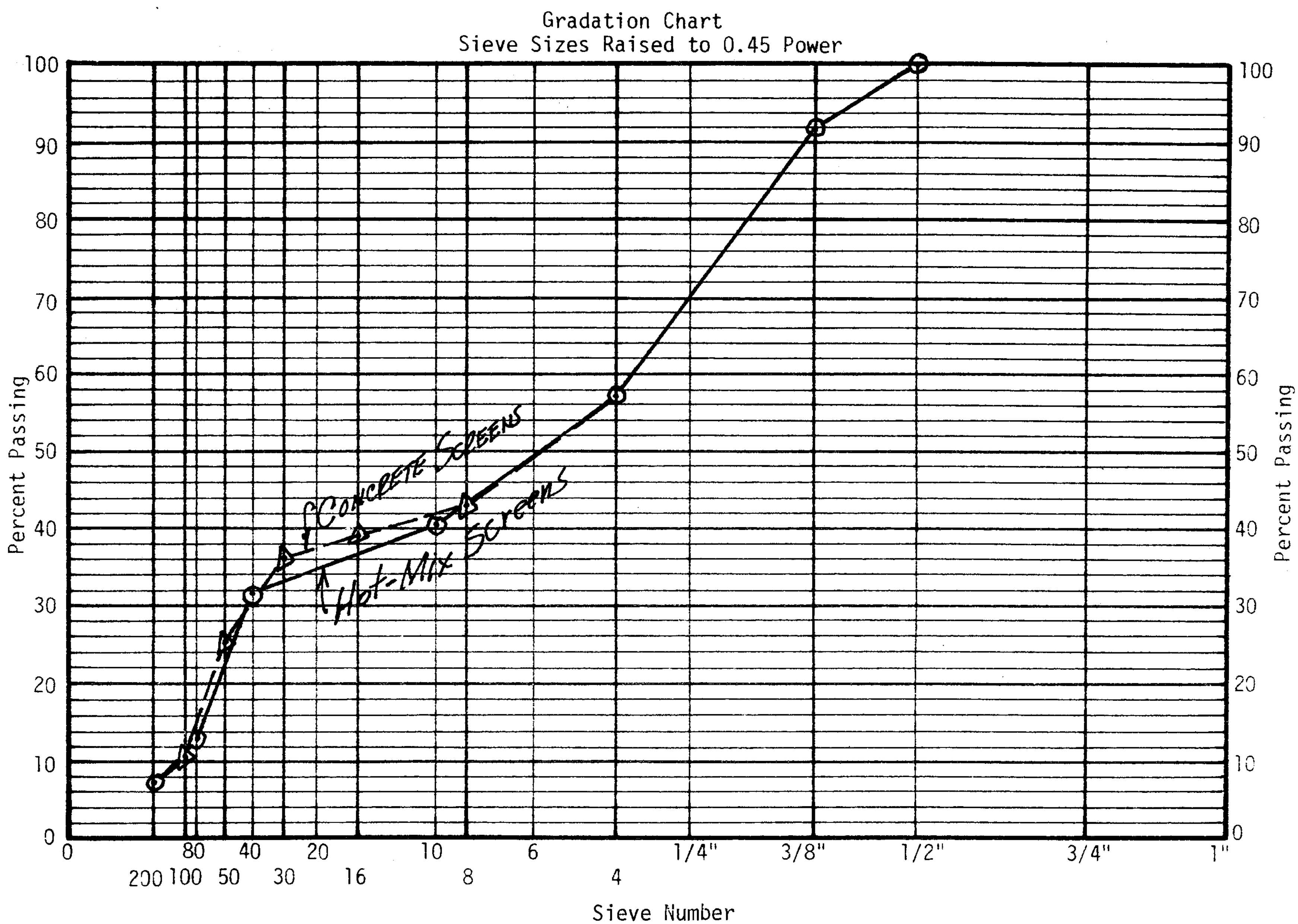

Figure 23. A comparison of the average results of using hot-mix sieves versus concrete sieves for wet sieving of Affiliated Aggregates aggregates from drum-dryer plant production, as taken from Table 5.

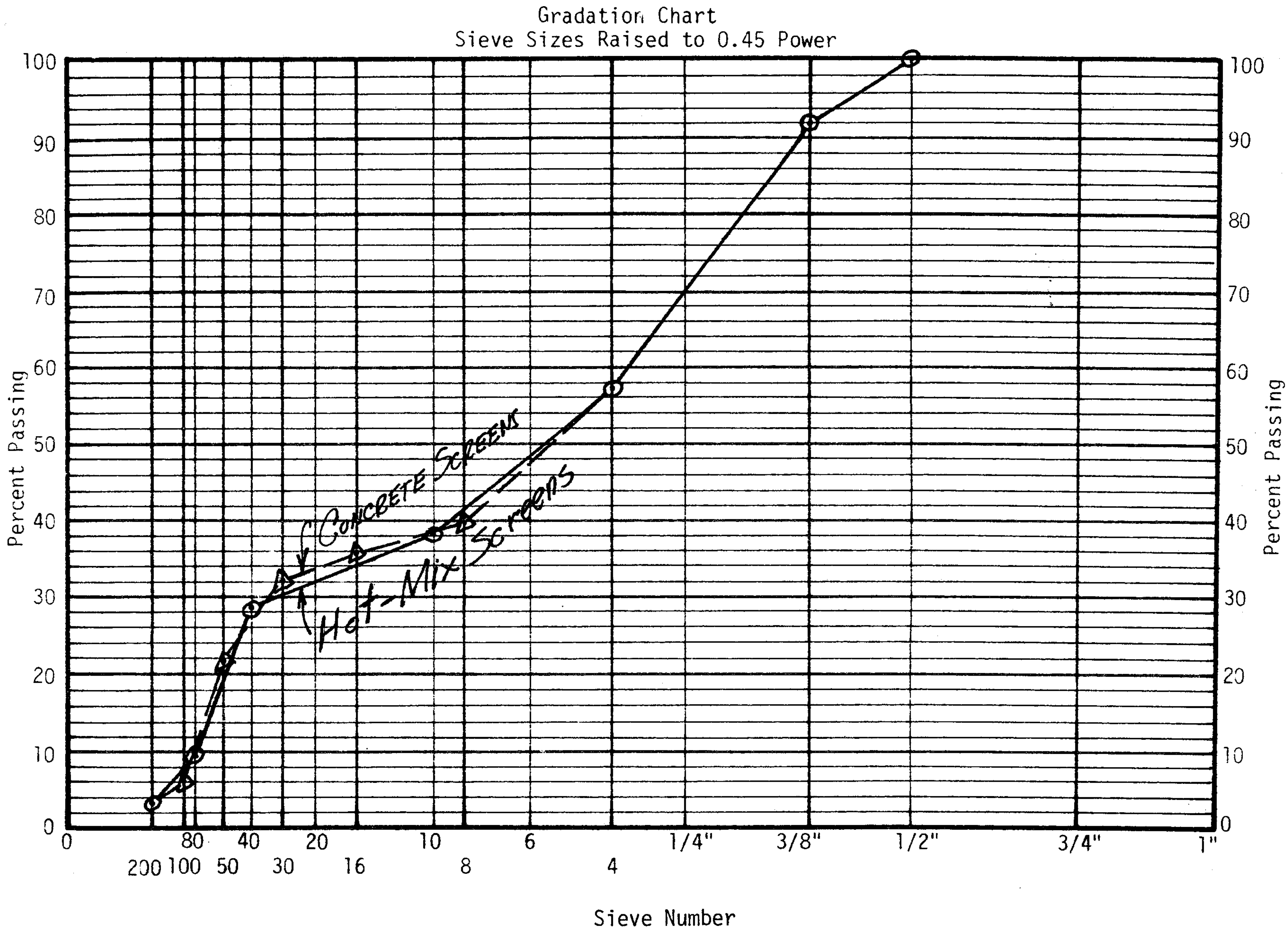

Figure 24. A comparison of the average results of using hot-mix sieves versus concrete sieves for extraction sieving of Affiliated Aggregates aggregates from drum-dryer plant production, as taken from Table 5.