

EVALUATION OF RETENTION FACTOR
AND MOISTURE CORRECTION FOR
DETERMINING ASPHALT CONTENT
IN ASPHALT CONCRETE MIXTURES

by

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100 INTRODUCTION

This report was undertaken as a result of the recommendations from the "Comparison of Sampling and Test Methods for Determining Asphalt Content and Moisture Correction in Asphalt Concrete Mixtures" report. For asphalt concrete mixture the OSHD Materials Laboratory compared three sources of aggregate, two methods of determining moisture content, and the differences in added asphalt and the extracted asphalt quantities.

110 Objective

The purpose of this report is to compare the differences in asphalt contents determined after correction of mix and extracted aggregate weights for moisture when drying with the standard oven and microwave oven. It is also intended to determine if the use of a retention factor is valid in the determination of asphalt content of asphalt concrete mixtures that are mixed with aggregate that contain moisture at the time of mixing with asphalt cement.

200 SOURCE OF SAMPLES

The aggregate for this study was initially oven dried and screened. Aggregate samples were then batched with a gradation of 100% pass 3/4, 87% pass 1/2, 65% pass 1/4, 54% pass #4, 31% pass #10, 12% pass #40, and 3.0% pass #200. These batched aggregate samples were dried again to obtain the dry weight of the sample. The first series of samples had asphalt added and were mixed at a dry aggregate condition. The second series of samples had 3.0% moisture added and the water was absorbed into the aggregate for 48 hours. The moist series of samples were then dried back in an oven to about 0.5 to 1.0% moisture, asphalt was added, and the sample was mixed.

There were a total of 47 samples prepared and tested for this report, 15 samples with dry aggregate and 32 samples with moist aggregate. Sample numbers 1 thru 23 were made up with aggregate from Hilroy Gravel Pit (Salem, Ore.), with the first 20 being moist samples and the last 3 being dry samples. Sample numbers 24 thru 29, dry samples, and 36 thru 41, moist samples, were made up with aggregate from Santosh Pit (Portland, Ore.). Sample numbers 30 thru 35, dry samples and 42 thru 47, moist samples, were made up with aggregate from Baker Rock Quarry (Portland, Ore.). Chevron AR4000W asphalt was used for all samples.

300 TEST PROCEDURES

Two drying methods were used on the samples for this study. The standard drying oven was used both to determine the moisture in the asphalt concrete mixtures and to dry the aggregate after the asphalt was extracted. This oven drying method was used on all the odd numbered samples. The microwave oven drying method was used to determine both the moisture in the asphalt concrete mixture and dry the aggregate after the asphalt was extracted. The microwave method was used on all even numbered samples.

The standard drying ovens were set at 230 F. The mixture samples were dried to a constant weight in 24 hours. The aggregate was dried to a constant weight. With the microwave oven a temperature of 250 F was the target for both the mix and extracted aggregate drying, but the aggregate had a tendency to heat higher than the target temperature of 250 F. Both methods for drying used the vacuum extractor to extract the asphalt from the asphalt concrete mixtures. The dried aggregate for both the standard drying oven and microwave drying method were dry sieved to determine the gradation.

400 ANALYSIS OF TEST RESULTS

The test results and averages are tabulated in tables 1a, 1b, 2a, 2b, 3a, and 3b. Data in Tables 1, 2, and 3 were developed from samples made with aggregate from Hilroy Gravel Pit, Santosh Pit, and Baker Rock Quarry, respectively. Tables 1a, 2a, and 3a show the results for each sample tested. Tables 1b, 2b, and 3b show the average for samples from the same aggregate source, drying method, percent asphalt added, and condition of aggregate at the time of mixing, i.e. dry or moist.

The results are also illustrated in figure form. Figures 1 thru 4 are of the Hilroy Gravel Pit samples. The first three are for mix that was produced with moist aggregate and had 5.0, 5.5, and 6.0 percent asphalt added at mixing, respectively. The fourth figure is for mix that was produced with oven dried aggregate. Figures 5 and 6 are for Santosh Pit samples. Figure 5 shows results for mix samples that were produced with moist aggregate. Figure 6 shows results for mixes from oven dried aggregate. Figures 7 and 8 are for Baker Rock Quarry samples. Figure 7 is for mix produced with moist aggregate and Figure 8 is for mix produced with oven dried aggregate.

500 CONCLUSIONS

1. It is standard practice for the O.S.H.D. Materials Testing Laboratory to determine a retention factor by fabricating an asphalt concrete sample using oven dried aggregate, then extracting the sample and determining an extracted asphalt content.
2. In this study, the asphalt concrete mixture and extracted aggregates were both dried by the same method. The odd numbered samples were tested using the standard drying oven. The even numbered samples were tested using the microwave oven drying method.
3. The test results from this study show that when oven dried aggregate was used, the extracted asphalt content was less than added asphalt content and a retention factor is appropriate.
4. In this study, the test results of the 32 samples fabricated with moist aggregate show that 29 had an extracted asphalt content equal to or greater than the added asphalt content. In this case a retention factor is inappropriate.
5. The percent moisture content, determined by the standard oven drying method, of asphalt concrete mixtures fabricated with moist aggregate, was higher than with the microwave method in all cases. By using the same drying method for both the mix and extracted aggregate, the average extracted asphalt content for the two drying methods were within 0.1 percent in most cases.

6. Moisture contents determined by the two drying methods for the asphalt concrete mixture samples that were fabricated with oven dried aggregate do not differ significantly. However, the average extracted asphalt contents for the standard oven dried method was 0.1 or 0.2 percent less than for the samples using the microwave oven method.

600 RECOMMENDATIONS

1. Over 90% of the extracted asphalt contents of the samples that were fabricated with moist aggregate are higher than the amount of asphalt added to the samples at the time of mixing. Since during the production of asphalt concrete mixture in the field the aggregate generally has moisture in it, the retention factor, if applied would only increase the error in the final measurement of asphalt used. Therefore, it is recommended that a retention factor not be added to the field vacuum extraction results.
2. The average extracted asphalt content calculated for the two drying methods differed by only 0.1 or 0.2 percent on the samples tested for this report. The difference was greater when the extracted aggregate from the asphalt concrete mixture was oven dried while the mix was microwave dried. Consequently, by using the same method for drying the mix and extracted aggregate, a more reliable asphalt content can be determined. Therefore, it is recommended that the same drying method be used for the mixture and the extracted aggregate from the mixture.

HILROY GRAVEL PIT
TEST DATA

Table 1a

SAMPLE NUMBER	DRYING METHOD	ASPHALT ADDED AT MIXING	ASPHALT EXTRACTED	MOISTURE CONTENT AT MIXING	MOISTURE CONTENT FROM TEST
1	Oven	5.0	5.2	0.6	0.45
2	Micro	5.0	5.2	0.8	0.24
3	Oven	5.0	5.2	1.0	0.65
4	Micro	5.0	5.2	1.0	0.33
5	Oven	5.0	5.0	1.0	0.60
6	Micro	5.0	5.2	1.0	0.34
7	Oven	5.5	5.7	0.7	0.54
8	Micro	5.5	6.0	1.0	0.16
9	Oven	5.5	5.7	1.0	0.66
10	Micro	5.5	5.7	0.9	0.22
11	Oven	5.5	5.5	0.7	0.48
12	Micro	5.5	5.7	1.0	0.29
13	Oven	5.5	5.7	1.0	0.58
14	Micro	5.5	5.7	1.0	0.38
15	Oven	6.0	6.0	0.8	0.65
16	Micro	6.0	6.1	0.9	0.34
17	Oven	6.0	6.0	1.0	0.59
18	Micro	6.0	6.1	0.8	0.33
19	Oven	6.0	6.2	1.0	0.64
20	Micro	6.0	6.1	0.9	0.37
21	Oven	5.5	5.3	0.0	0.02
22	Micro	5.5	5.3	0.0	0.07
23	Oven	5.5	5.4	0.0	0.04

HILROY GRAVEL PIT
MOISTURE AND ASPHALT CONTENT AVERAGES

Table 1b

<u>SAMPLE NUMBERS</u>	<u>DRYING METHOD</u>	<u>ASPHALT ADDED AT MIXING</u>	<u>AVERAGE ASPHALT EXTRACTED</u>	<u>AVERAGE MOISTURE CONTENT AT MIXING</u>	<u>AVERAGE MOISTURE CONTENT FROM TEST</u>
1, 3, 5	Oven	5.0	5.1	0.9	0.57
2, 4, 6	Micro	5.0	5.2	0.9	0.30
7, 9, 11, 13	Oven	5.5	5.7	0.9	0.57
8, 10, 12, 14	Micro	5.5	5.8	1.0	0.26
15, 17, 19	Oven	6.0	6.1	0.9	0.63
16, 18, 20	Micro	6.0	6.1	0.9	0.35

SANTOSH PIT (GRAVEL)
TEST DATA

Table 2a

<u>SAMPLE NUMBER</u>	<u>DRYING METHOD</u>	<u>ASPHALT ADDED AT MIXING</u>	<u>ASPHALT EXTRACTED</u>	<u>MOISTURE CONTENT AT MIXING</u>	<u>MOISTURE CONTENT FROM TEST</u>
24	Micro	5.5	5.2	0.0	0.12
25	Oven	5.5	5.4	0.0	0.05
26	Micro	5.5	5.3	0.0	0.09
27	Oven	5.5	5.5	0.0	0.05
28	Micro	5.5	5.3	0.0	0.09
29	Oven	5.5	5.4	0.0	0.08
36	Micro	5.5	5.6	0.68	0.35
37	Oven	5.5	5.6	0.90	0.49
38	Micro	5.5	5.5	0.70	0.28
39	Oven	5.5	5.5	0.70	0.45
40	Micro	5.5	6.0	0.78	0.27
41	Oven	5.5	5.8	0.75	0.45

SANTOSH PIT (GRAVEL)
MOISTURE AND ASPHALT CONTENT AVERAGES

Table 2b

<u>SAMPLE NUMBERS</u>	<u>DRYING METHOD</u>	<u>ASPHALT ADDED AT MIXING</u>	<u>AVERAGE ASPHALT EXTRACTED</u>	<u>AVERAGE MOISTURE CONTENT AT MIXING</u>	<u>AVERAGE MOISTURE CONTENT FROM TEST</u>
24, 26, 28	Micro	5.5	5.3	0.00	0.10
25, 27, 29	Oven	5.5	5.4	0.00	0.06
36, 38, 40	Micro	5.5	5.7	0.72	0.30
37, 39, 41	Oven	5.5	5.6	0.78	0.46

BAKER ROCK QUARRY
TEST DATA

Table 3 a

<u>SAMPLE NUMBER</u>	<u>DRYING METHOD</u>	<u>ASPHALT ADDED AT MIXING</u>	<u>ASPHALT EXTRACTED</u>	<u>MOISTURE CONTENT AT MIXING</u>	<u>MOISTURE CONTENT FROM TEST</u>
30	Micro	5.5	5.2	0.00	0.11
31	Oven	5.5	5.4	0.00	0.14
32	Micro	5.5	5.3	0.00	0.11
33	Oven	5.5	5.3	0.00	0.11
34	Micro	5.5	5.0	0.00	0.08
35	Oven	5.5	5.1	0.00	0.09
42	Micro	5.5	5.7	1.03	0.45
43	Oven	5.5	5.4	0.98	0.66
44	Micro	5.5	5.7	1.03	0.45
45	Oven	5.5	5.5	0.92	0.57
46	Micro	5.5	5.4	0.47	0.18
47	Oven	5.5	5.2	0.71	0.35

BAKER ROCK QUARRY
MOISTURE AND ASPHALT CONTENT AVERAGES

Table 3b

<u>SAMPLE NUMBERS</u>	<u>DRYING METHOD</u>	<u>ASPHALT ADDED AT MIXING</u>	<u>AVERAGE ASPHALT EXTRACTED</u>	<u>AVERAGE MOISTURE CONTENT AT MIXING</u>	<u>AVERAGE MOISTURE CONTENT FROM TEST</u>
30, 32, 34	Micro	5.5	5.2	0.00	0.10
31, 33, 35	Oven	5.5	5.3	0.00	0.11
42, 44, 46	Micro	5.5	5.6	0.84	0.36
43, 45, 47	Oven	5.5	5.4	0.64	0.53

HILROY GRAVEL PIT

(AGGREGATE MOIST AT TIME OF MIXING)

FIGURE 1a EXTRACTED A/C VS. SAMPLE NO.

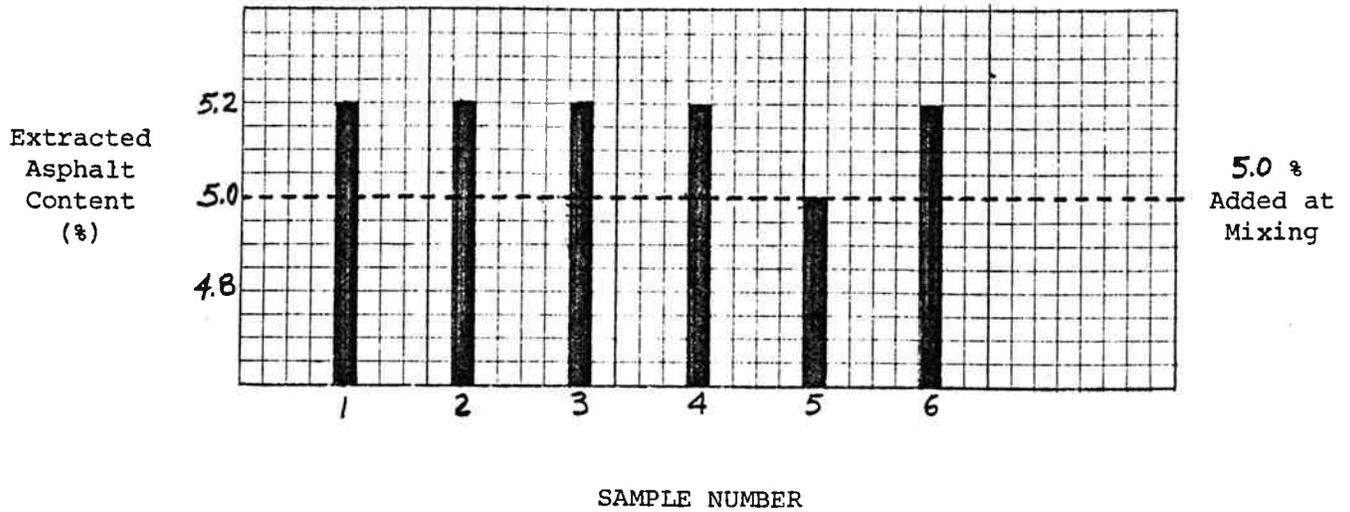
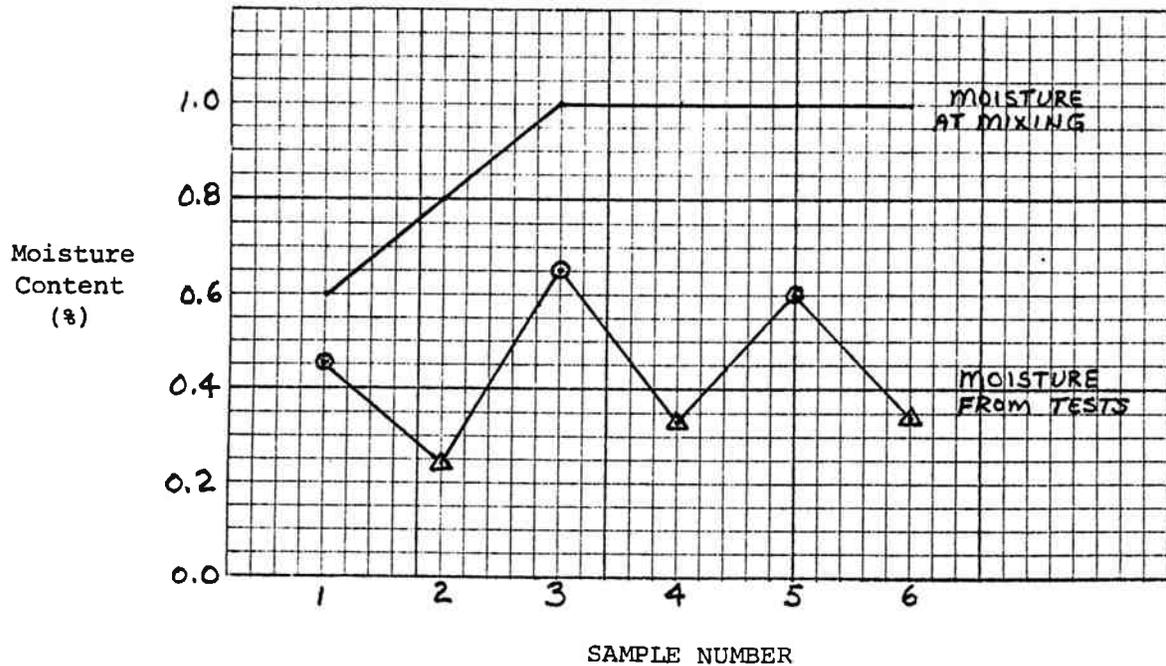


FIGURE 1b MOISTURE CONTENT VS. SAMPLE NO.



Note: \odot - Oven Tested
 \triangle - Micro Tested

HILROY GRAVEL PIT

(AGGREGATE MOIST AT TIME OF MIXING)

FIGURE 2a EXTRACTED A/C VS. SAMPLE NO.

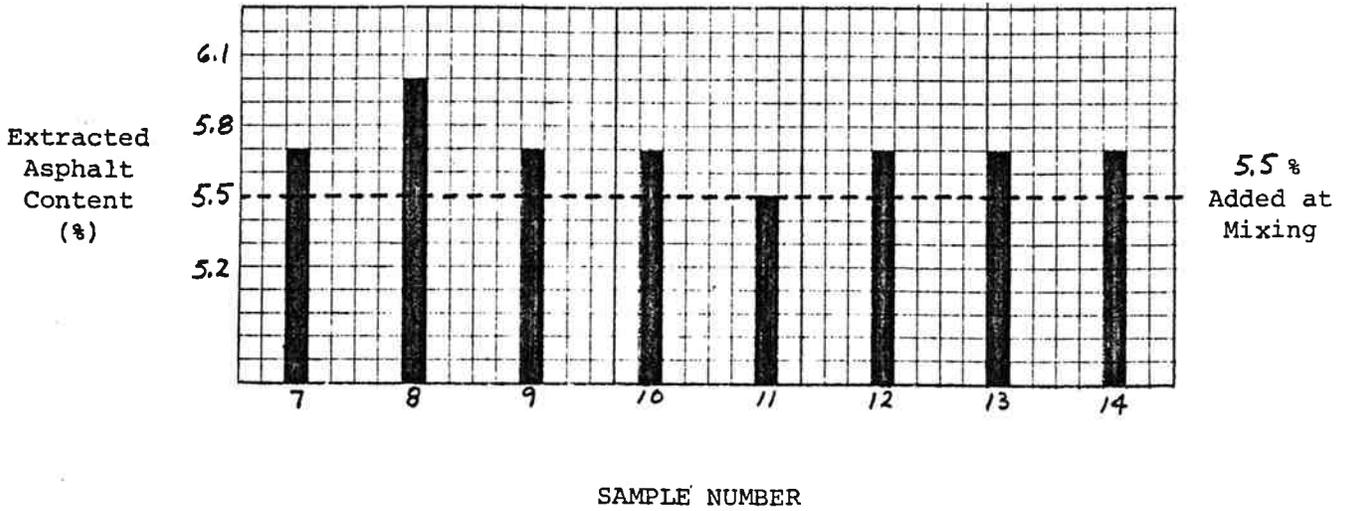
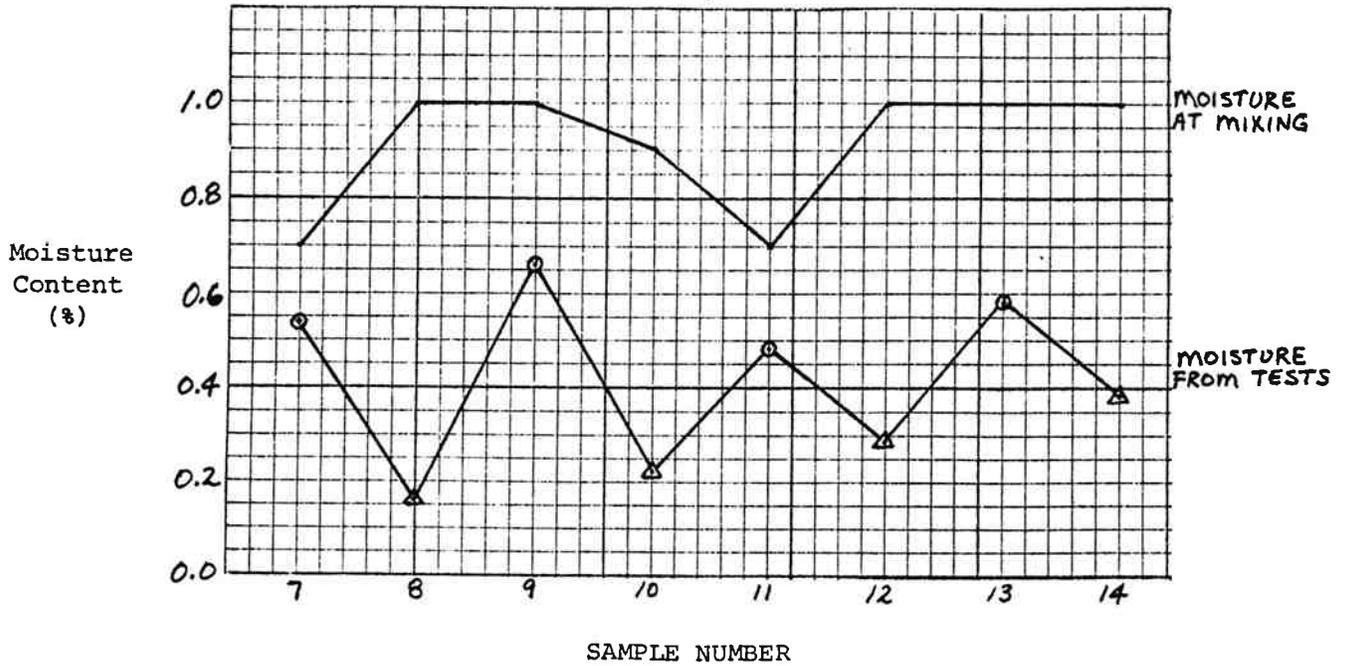


FIGURE 2b MOISTURE CONTENT VS. SAMPLE NO.



Note: ○ - Oven Tested
▲ - Micro Tested

HILROY GRAVEL PIT

(AGGREGATE MOIST AT TIME OF MIXING)

FIGURE 3a EXTRACTED A/C VS. SAMPLE NO.

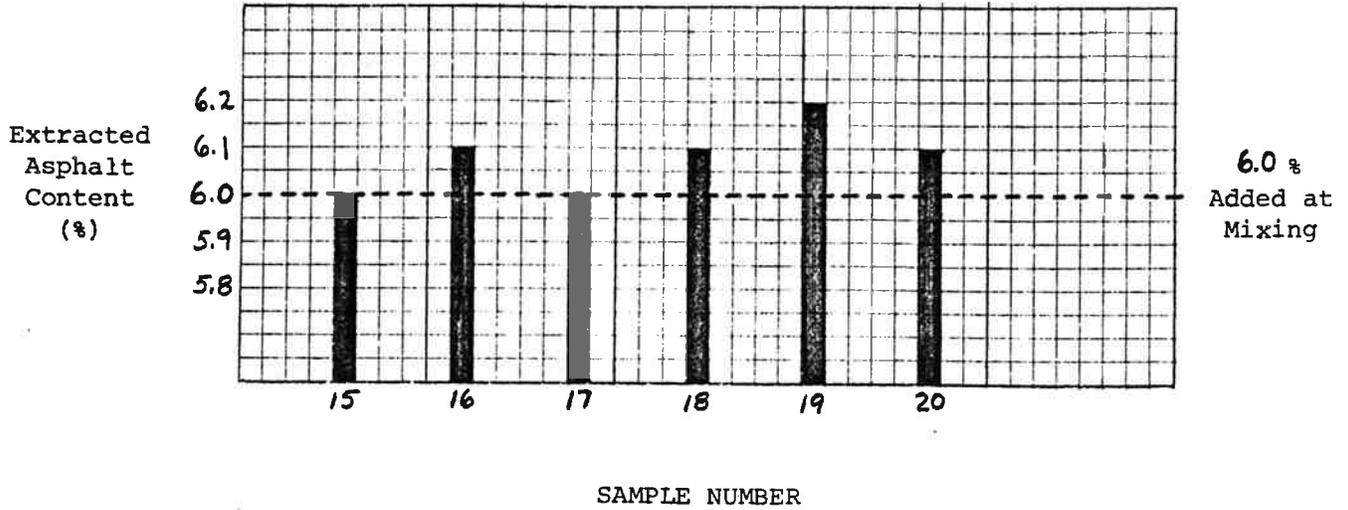
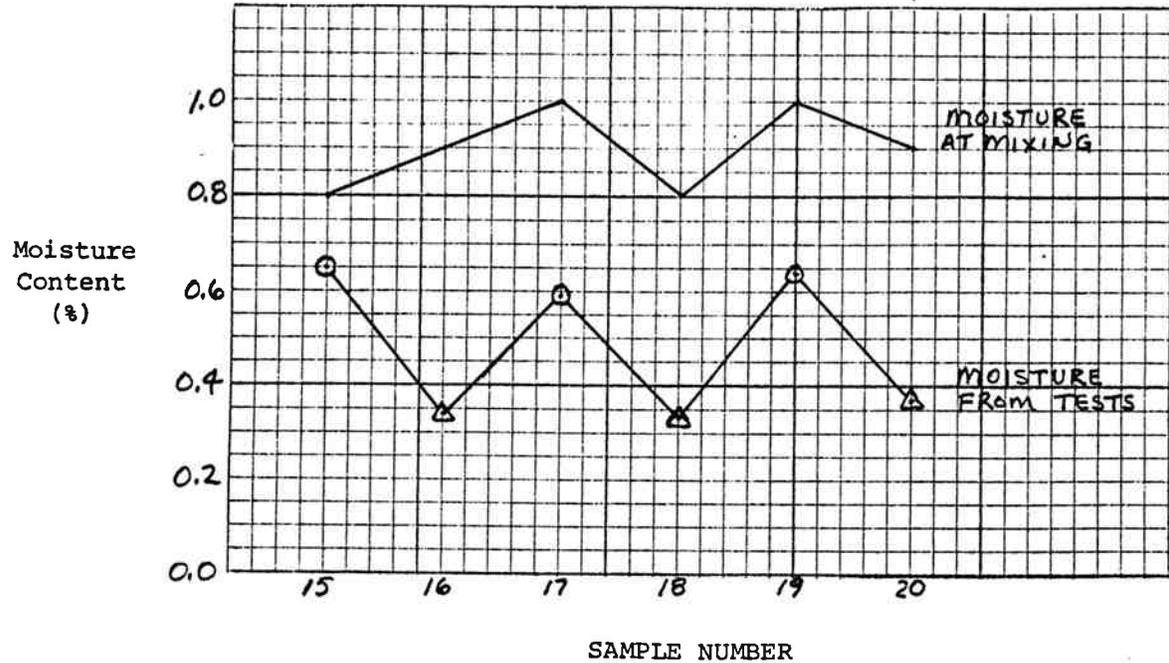


FIGURE 3b MOISTURE CONTENT VS. SAMPLE NO.



Note: ○ - Oven Tested
△ - Micro Tested

HILROY GRAVEL PIT

(AGGREGATE DRY AT TIME OF MIXING)

FIGURE 4a EXTRACTED A/C VS. SAMPLE NO.

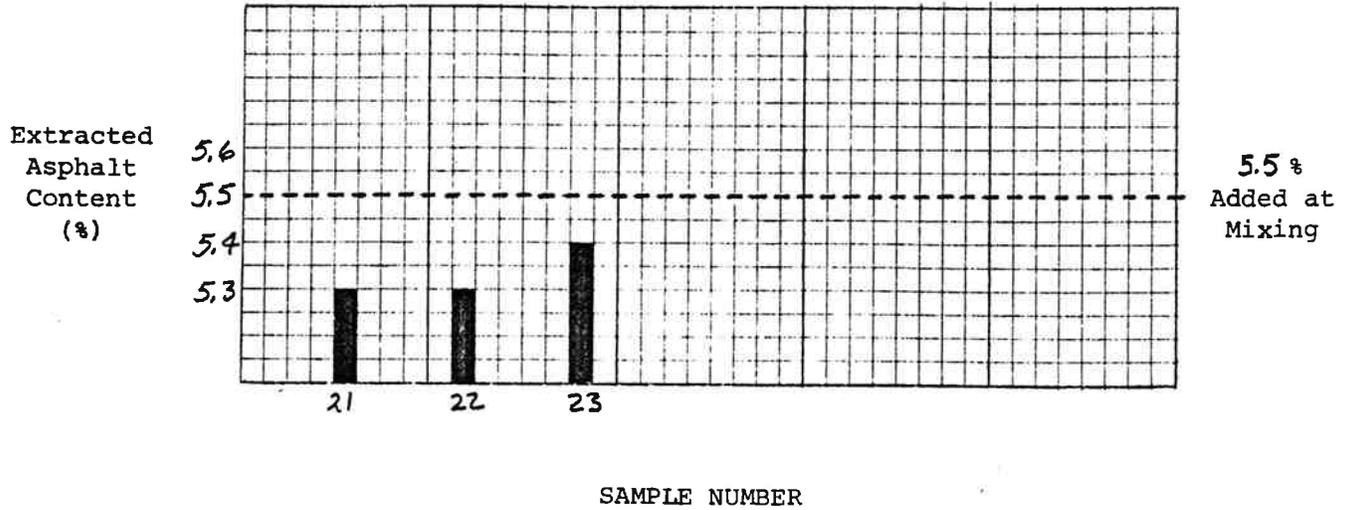
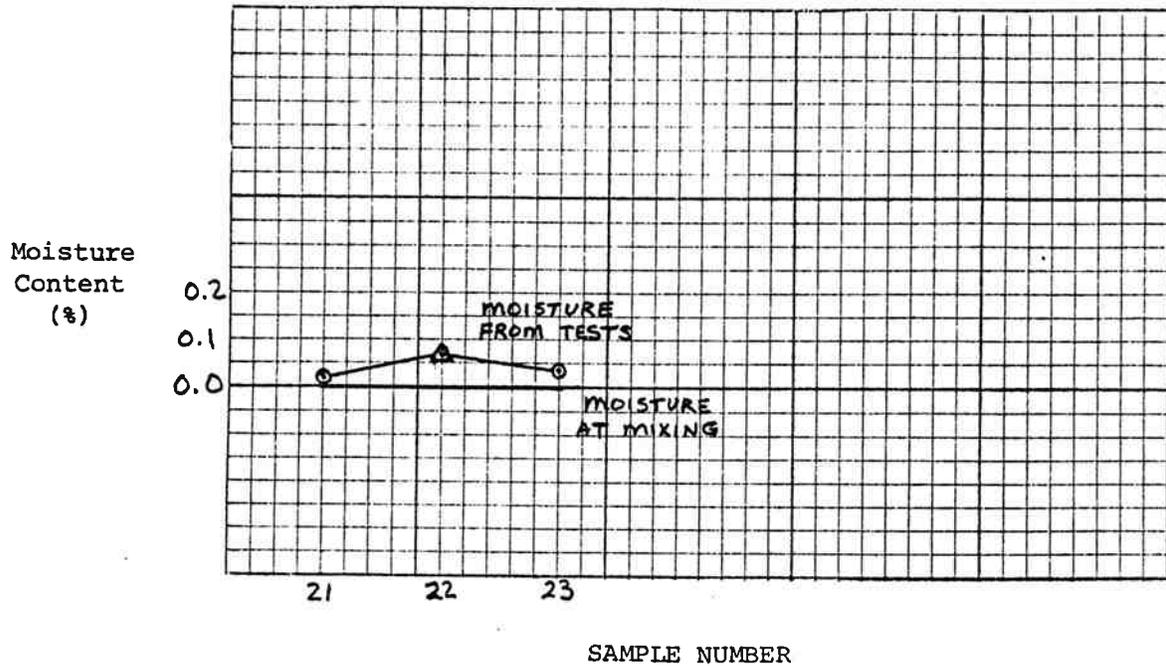


FIGURE 4b MOISTURE CONTENT VS. SAMPLE NO.



Note: ○ - Oven Tested
△ - Micro Tested

SANTOSH PIT (GRAVEL)
(AGGREGATE MOIST AT TIME OF MIXING)

FIGURE 5a EXTRACTED A/C VS. SAMPLE NO.

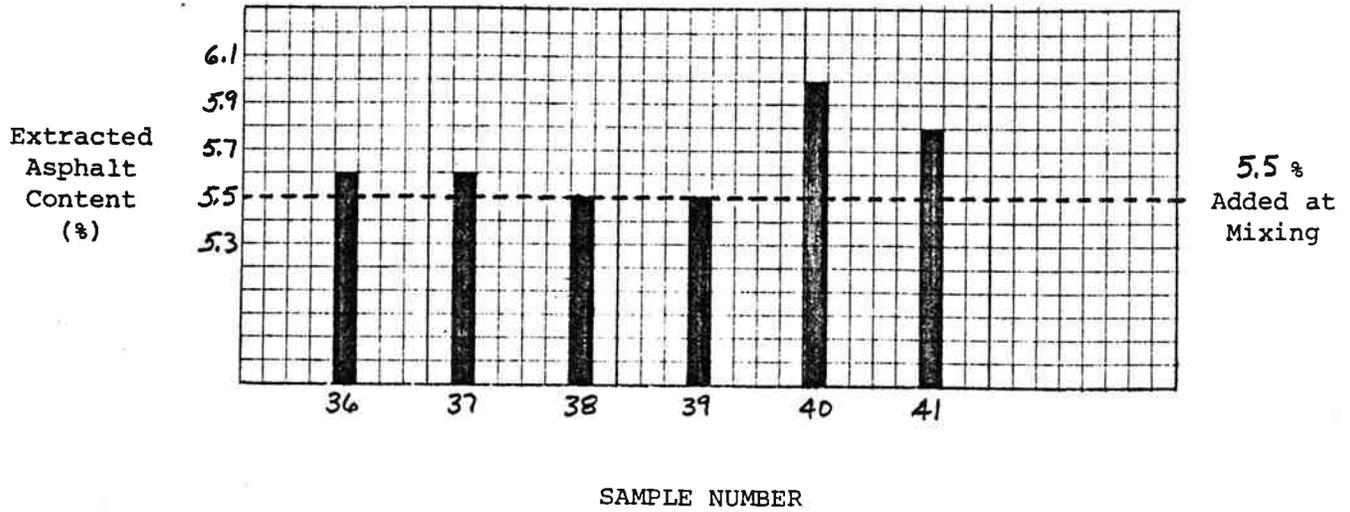
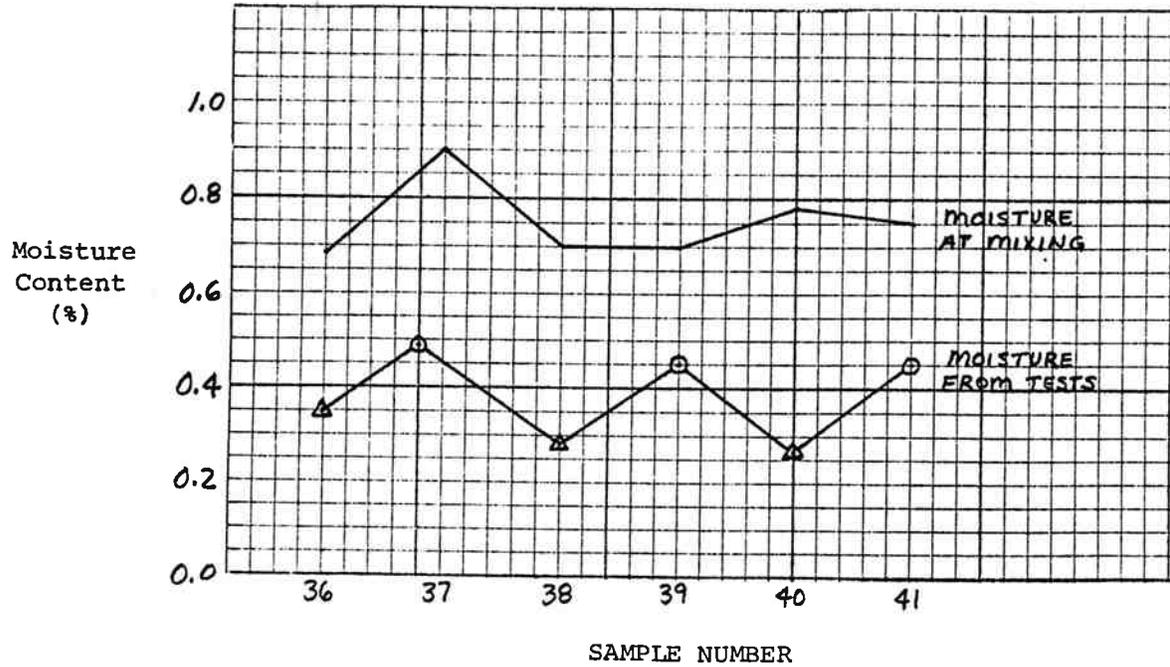


FIGURE 5b MOISTURE CONTENT VS. SAMPLE NO.



Note: ○ - Oven Tested
△ - Micro Tested

SANTOSH PIT (GRAVEL)
(AGGREGATE DRY AT TIME OF MIXING)

FIGURE 6a EXTRACTED A/C VS. SAMPLE NO.

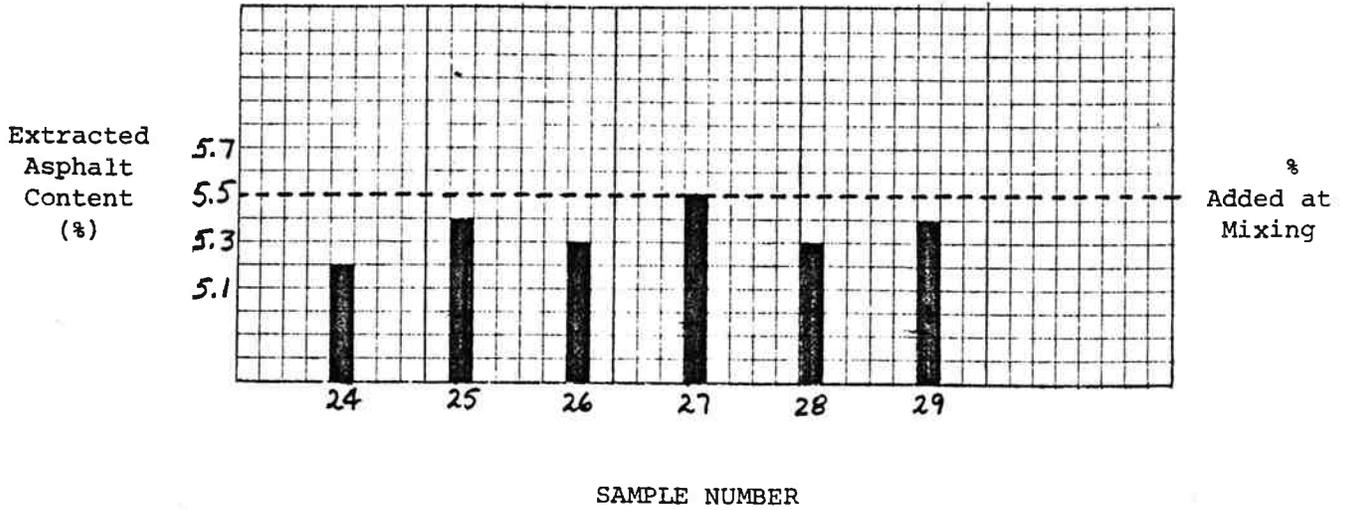
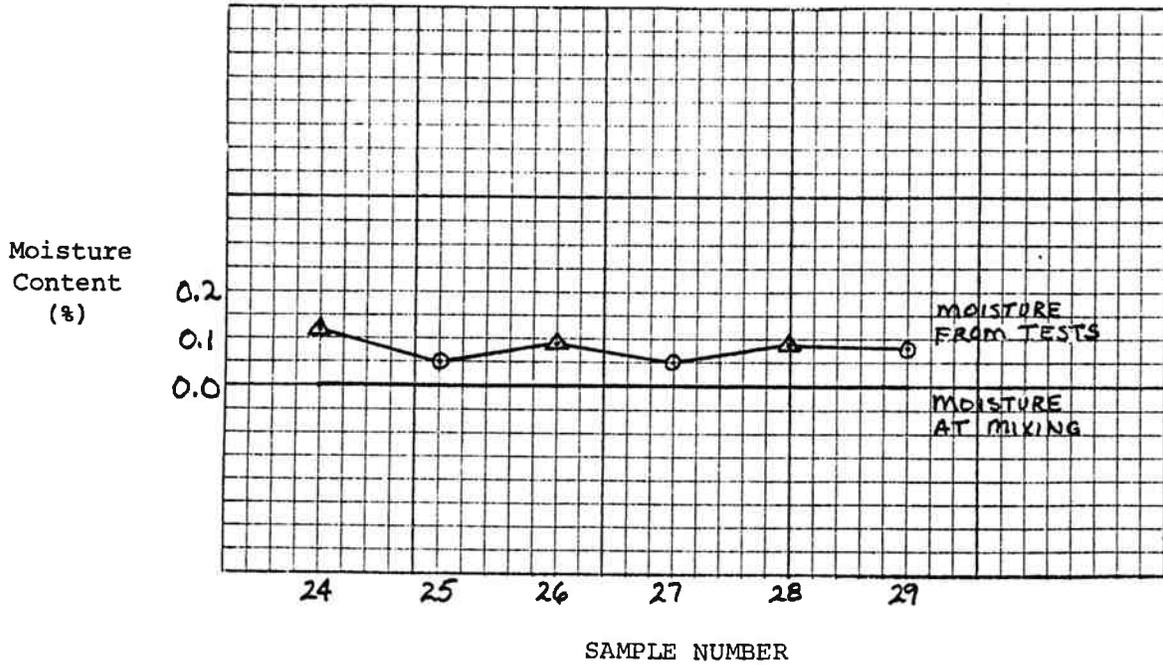


FIGURE 6b MOISTURE CONTENT VS. SAMPLE NO.



Note: \odot - Oven Tested
 \triangle - Micro Tested

BAKER ROCK QUARRY

(AGGREGATE MOIST AT TIME OF MIXING)

FIGURE 7a EXTRACTED A/C VS. SAMPLE NO.

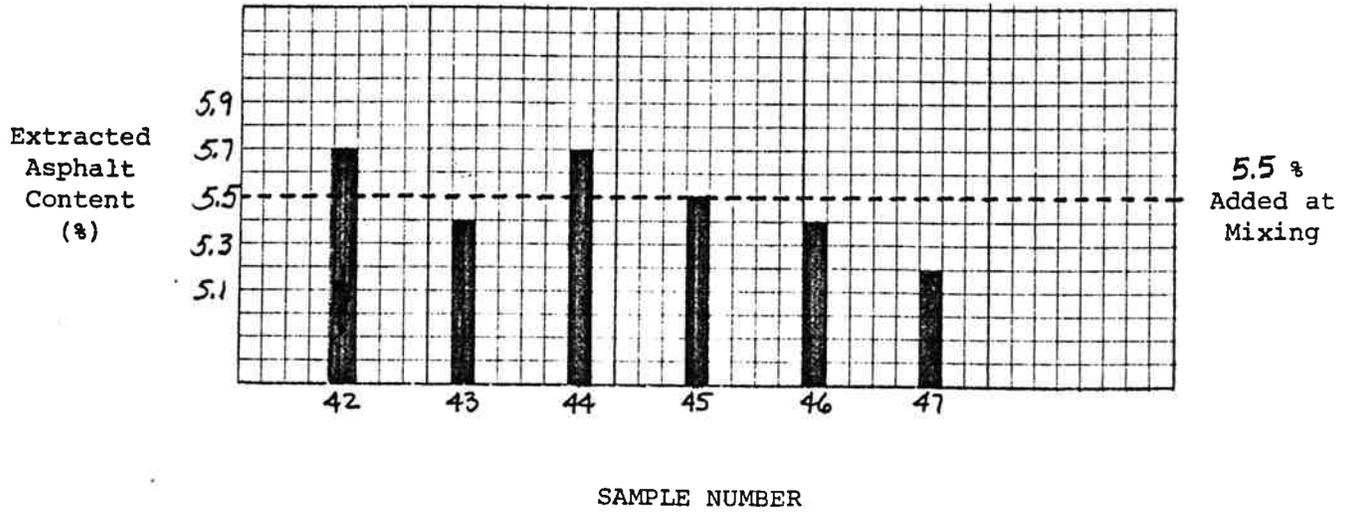
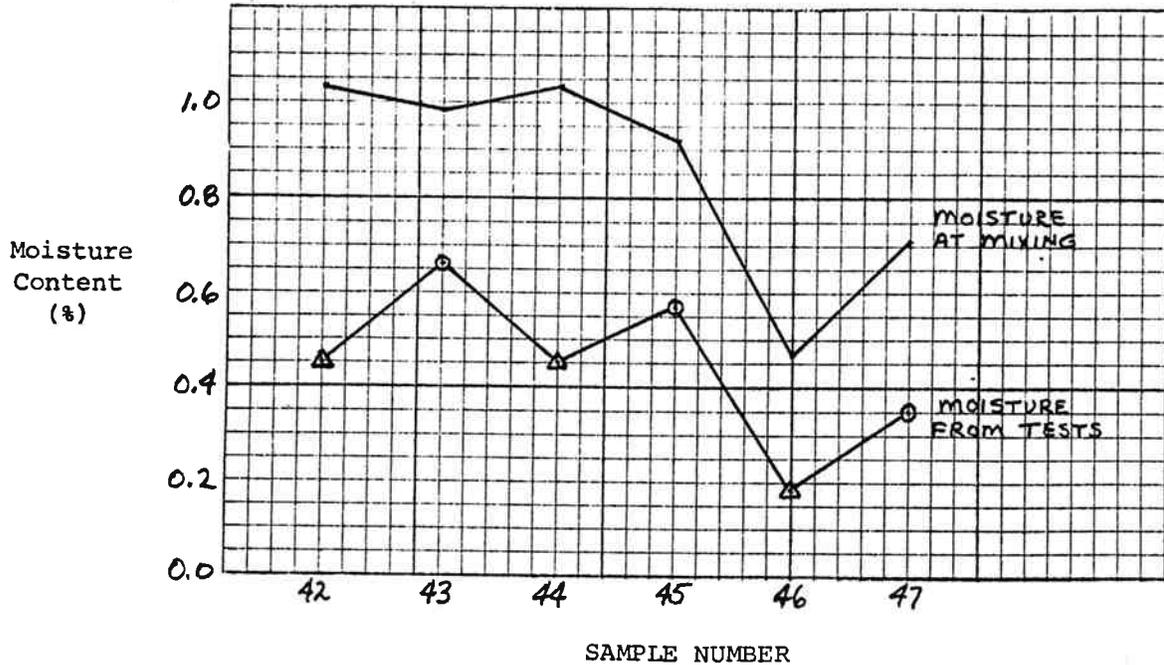


FIGURE 7b MOISTURE CONTENT VS. SAMPLE NO.



Note: \odot - Oven Tested
 \triangle - Micro Tested

BAKER ROCK QUARRY

(AGGREGATE DRY AT TIME OF MIXING)

FIGURE 8a EXTRACTED A/C VS. SAMPLE NO.

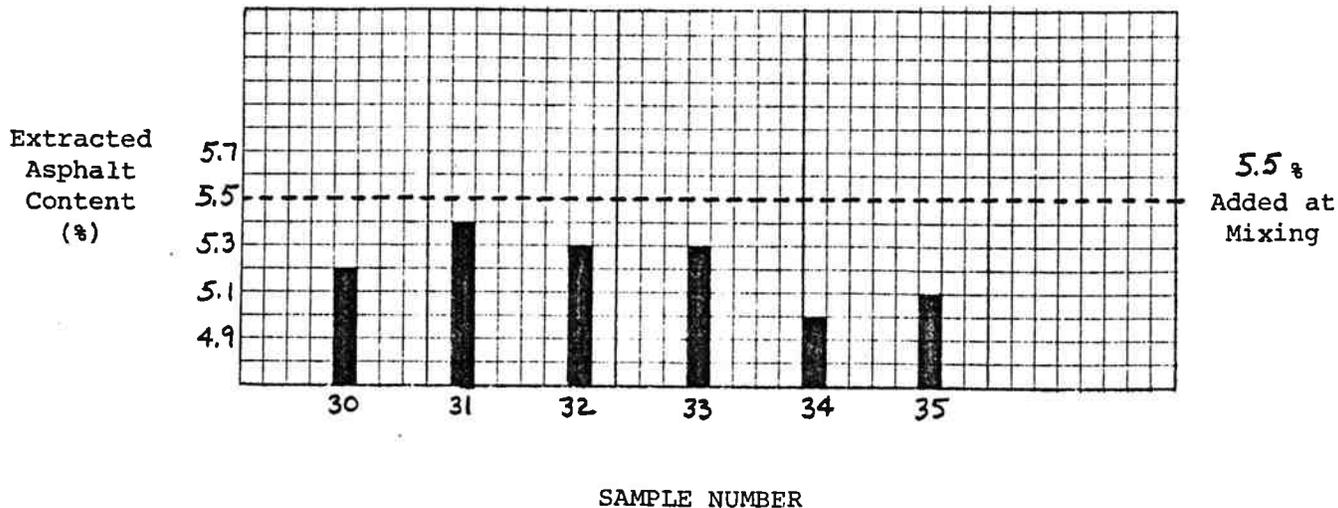
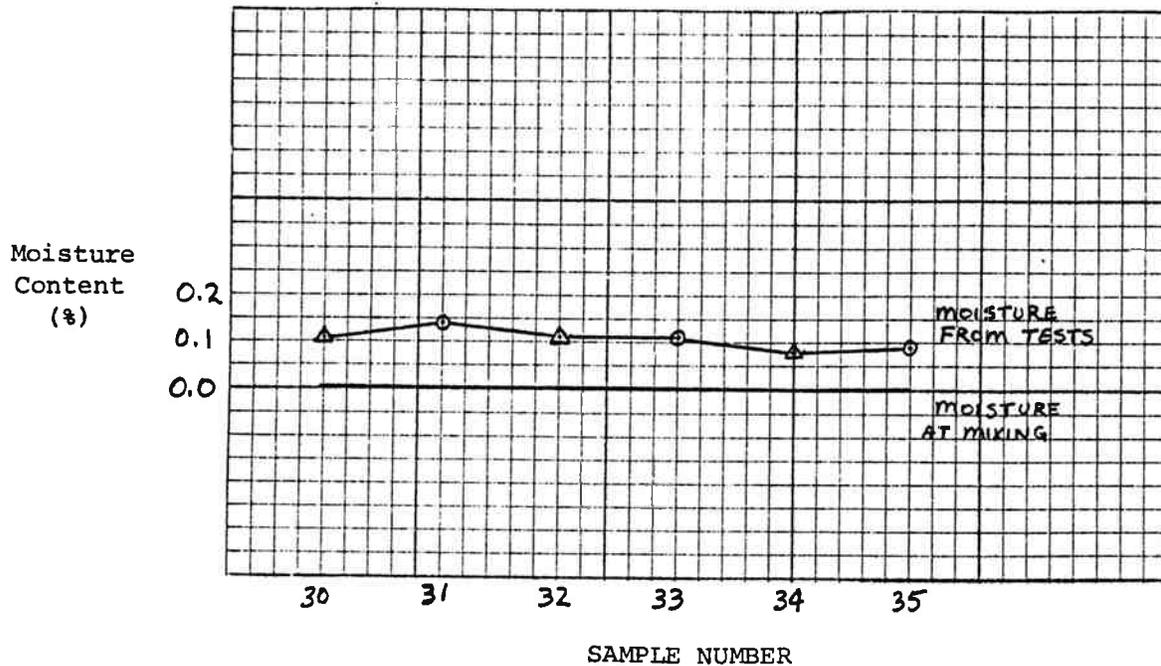


FIGURE 8b MOISTURE CONTENT VS. SAMPLE NO.



Note: \odot - Oven Tested
 \triangle - Micro Tested