PRELIMINARY DRAFT - NOT FOR PUBLICATION

AGGREGATE COMPATIBILITY WITH EMULSION SYSTEMS
PART I - EXPERIMENTS IN AMINE SORPTION ONTO AGGREGATE SURFACES

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A PRELIMINARY REPORT FOR PRESENTATION TO THE ISSA R&D COMMITTEE AT THE ISSA 29TH CONVENTION FEBRUARY 17-21, 1991 - NEW ORLEANS

INTRODUCTION

The compatibility or "friendliness" between a given emulsifier system and a range of aggregate chemistries is critical to the success or failure of microasphalt surfaces. Of the estimated 1300 different chemical types of aggregate in the U.S., many have been found chemically unsuitable for use in high performance systems while only a very few have been found desirable.

In order to simplify the selection process, we propose a study to include a number of experiments to determine the best route to meet our objective. These experiments would include:

1. Identification of a significant number of known "friendly" aggregates as well as poor, "unfriendly" aggregates.

2. Perform a complete detailed chemical analysis by X-ray diffraction or Plasma techniques of all aggregates for statistical analysis of common characteristics for each class.

3. Examine the aggregate surface physical chemistry, crystalline structure, solubilities, Zeta potential, complete cation exchange capacity, wetability, methylene blue, presense and quantity of counterions, as well as many other tests that may prove meaningful.

4. Examine the direct absorbtion of specific emulsifiers by David Stewart's Ion Specific Electrode procedure or by the determination of differential total amine values before and after aggregate exposure to specific emulsifiers by the Troy Mullins procedure or by titration differentials.

5. Confirm by physical mix tests such as the Schulze-Breuer-Ruck filler compatibility test using known, suitable bitumen.

6. Study the "Calcium Link" (Calcium Oxide-Calcium Sicilicate) phenomena as well as other materials or additives known to improve or degrade adhesion and cohesion.

7. A comprehensive literature search.

As we get into the project, we'll no doubt need to add and subtract various areas of study. We know of at least 3 other labs working along a similar track and hope that ideas will be exchanged.

PART I - EXPERIMENTS IN AMINE ABORBTION ONTO AGGREGATE SURFACES

Our initial work objective was to discover whether or not absorbtion of amine-type emulsifiers could be measured by a simple titration technique. Our initial approach was to make aqeous dispersions at various higher pH values (to avoid carbonate reactions) mix with aggregate, filter and titrate against bromo-phenol blue a blank solution and compare the filtrate titration.

Aqueous dispersions did poorly as did the blue indicator. After experimentation, we settled on IPA solutions throughout; .02N HCl, .10 gram emulsifier in 60 grams IPA, Whatman #40 first and finish with #50 (2.5um) filter paper. A pH meter was used.

Four common microsurface emulsifiers (3E,4E,5E & 6E) were used with 3 aggregates (Latham Dolomite, Verdon Granite and Xenia Gravel). The aggregates were washed through the #10 (2mm) and retained on the #30 (600um) screens.

Blanks with only emulsifier were first titrated against the .02N HCl. After 30 minutes exposure to 10 grams of aggregate to the emulsifier solution and filtration, the total filtrate was titrated. The different titration curves were plotted and the difference between blank and reacted filtrate were calculated as the milligrams of emulsifier per gram of aggregate at 3.0 pH. (Figures 1-5).

We than experimented with the effect of .25% incremental additions of type I Portland Cement. (Figures 6 & 7).

DISCUSSION

The method appears to have promise. Constant known surface area is a troubling variable as is absorbtion into the aggregate.

It appears that Granite required similar amounts of each emulsifier but that the lower TAV emulsifiers required more emulsifier than the higher TAV's. This seems to hold true with Dolomite when the 3E and 6E emulsifier's are used.

However, radically more 4E was required while radically less 5E (1/5th the amount) is required. Perhaps the molecular structure of 4E allows a greater exchange while the structure of 5E repulses the particular type of reactive sites on the Dolomite. We have noted problems with the 5E emulsifier, even at low use levels, of low internal wet cohesion (4-5 hours to set) and extreme water sensitivity with Dolomites but no problem with Granite.

Incremental additions of type I Portland (.25% by aggregate weight) while using 4E emulsifier and Dolomite all yielded the same increased emulsifier absorbtion except at .5% cement. Where a severe reduction takes place, we can't help but wonder if there is a relation to our previous optimum wet cohesion curves for this same system. (Figures 6 & 7).

No conclusions can be made until we have repeated our results and verified them in other ways. We simply pass on these observations to interested researchers.

REFERENCES:

-Troy Mullins at Laramie ca. 1985 on TAV leachote

-David Stewart at ISSA, 1990 on ISE Measurement of Aggregate Demand for Emulsifier

-C.R. Benedict of ISSA 1990 on System of Optimization

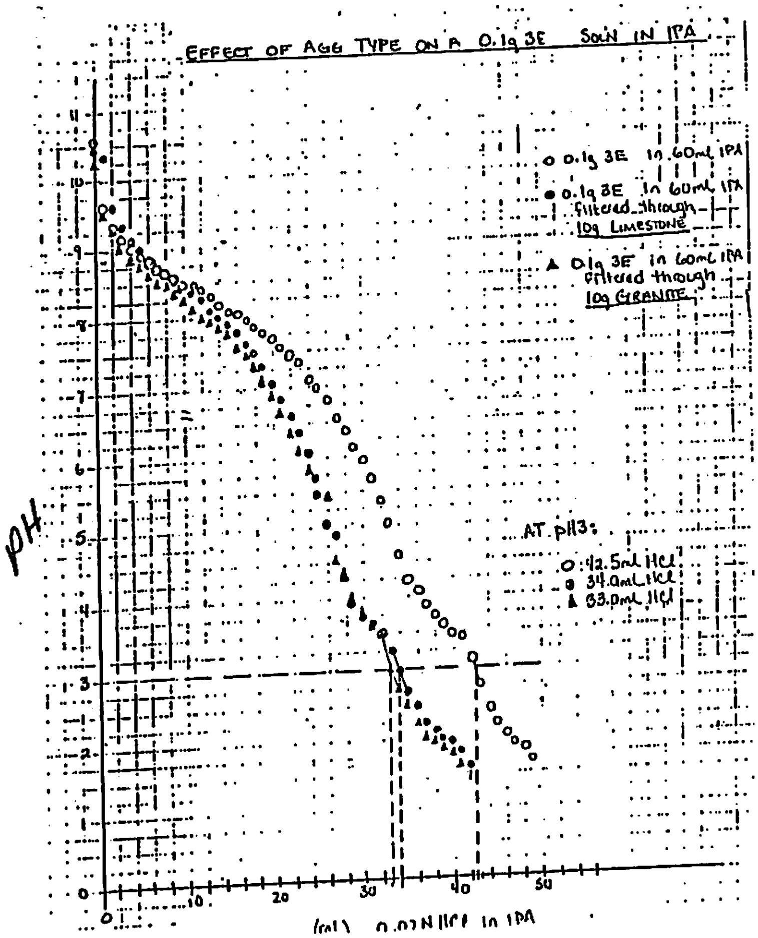
Table 1 **EMULSIFIER SORBTION ONTO AGGREGATE SURFACES- TITRAMETRIC METHOD**

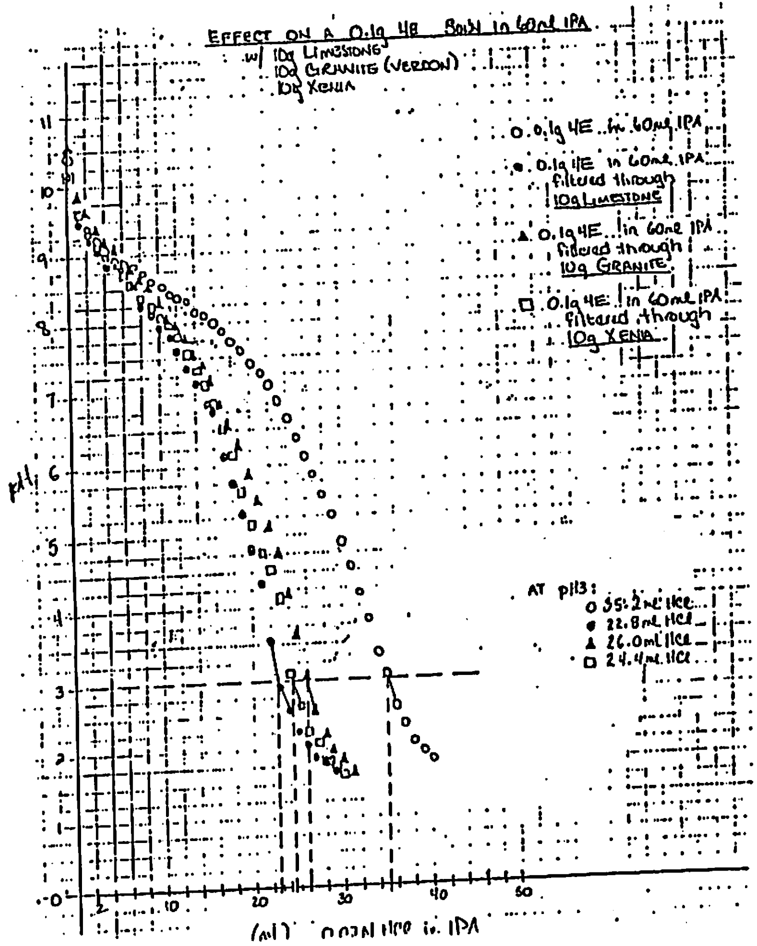
Emulsifier Ident.	TAV Range	Dolomite	Granite	Gravel
		mg. Emulsifier/gram Aggregate		
3E	500	2.0	2.2	-
4E	400	3.5	2.6	3.1
5E	500	.7	2.4	-
6E	(360)+	(2.2)	(2.7)	(2.6)

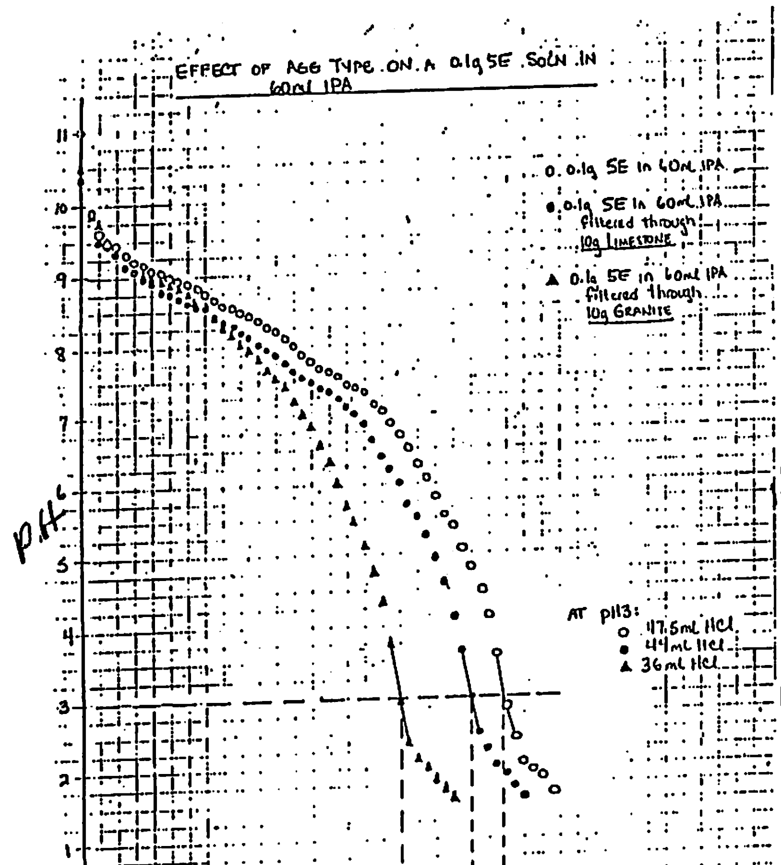
*(100% Active)

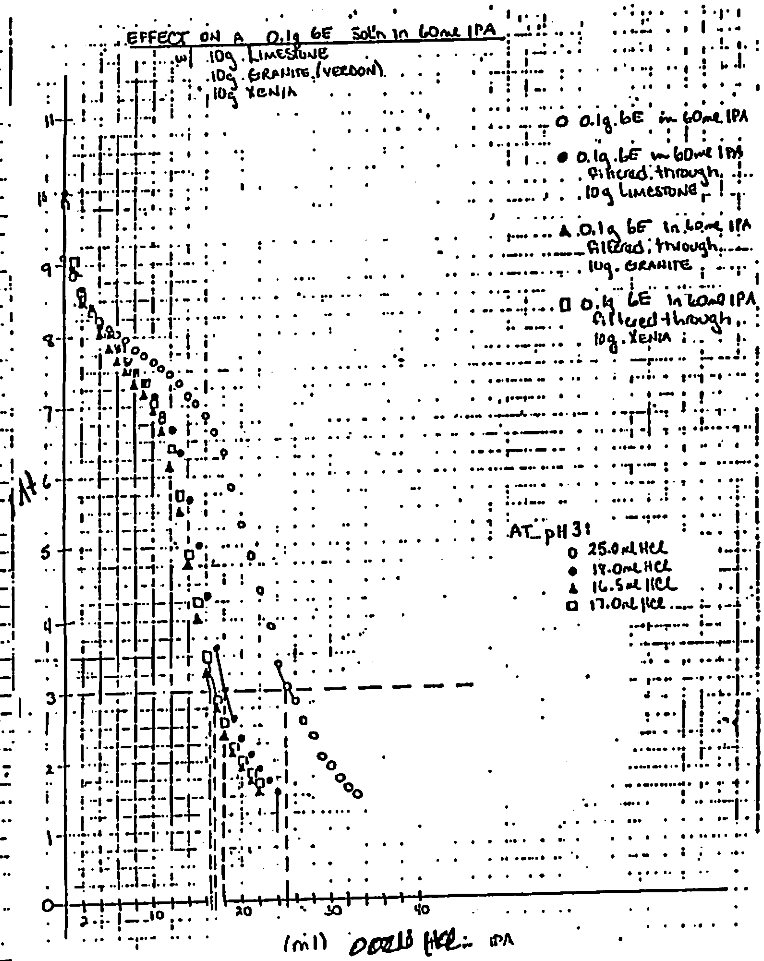
Table 2 **EFFECT OF CEMENT ON 4E EMULSIFIER SORPTION ONTO DOLOMITE SURFACE**

% Cement	mg 4E/g. Agg
0	3.5
.25	4.6
.50	2.5
.75	4.6
1.00	4.2


EFFECT OF AGG TYPE ON A 0.1g 3E SOL'N IN IPA
o 0.1g 3E in 60mL IPA
● 0.1g 3E in 60mL IPA filtered through 10g LIMESTONE
▲ 0.1g 3E in 60mL IPA filtered through 10g GRANITE
AT pH3:
o 42.5mL HCl
● 34.0mL HCl
▲ 33.0mL HCl
pH
(ml) 0.02N HCl in IPA


EFFECT ON A 0.1g 4E SOL'N in 60mL IPA
w/ 10g LIMESTONE
10g GRANITE (VERDON)
10g XENIA
o 0.1g 4E in 60mL IPA
● 0.1g 4E in 60mL IPA filtered through 10g LIMESTONE
▲ 0.1g 4E in 60mL IPA filtered through 10g GRANITE
□ 0.1g 4E in 60mL IPA filtered through 10g XENIA
AT pH3:
o 35.2mL HCl
● 22.8mL HCl
▲ 26.0mL HCl
□ 24.4mL HCl
pH
(ml) 0.02N HCl in IPA


EFFECT OF AGG TYPE ON A 0.1g 5E SOL'N IN 60mL IPA
o 0.1g 5E in 60mL IPA
● 0.1g 5E in 60mL IPA filtered through 10g LIMESTONE
▲ 0.1g 5E in 60mL IPA filtered through 10g GRANITE
AT pH3:
o 47.5mL HCl
● 44mL HCl
▲ 36mL HCl
pH
(ml) 0.02N HCl in IPA


EFFECT ON A 0.1g 6E SOL'N in 60mL IPA
w/ 10g LIMESTONE
10g GRANITE (VERDON)
10g XENIA
o 0.1g 6E in 60mL IPA
● 0.1g 6E w 60mL IPA filtered through 10g LIMESTONE
▲ 0.1g 6E in 60mL IPA filtered through 10g GRANITE
□ 0.1g 6E in 60mL IPA filtered through 10g XENIA
AT pH3:
o 25.0mL HCl
● 19.0mL HCl
▲ 16.5mL HCl
□ 17.0mL HCl
pH
(ml) 0.02N HCl in IPA

FIGURES 1-4

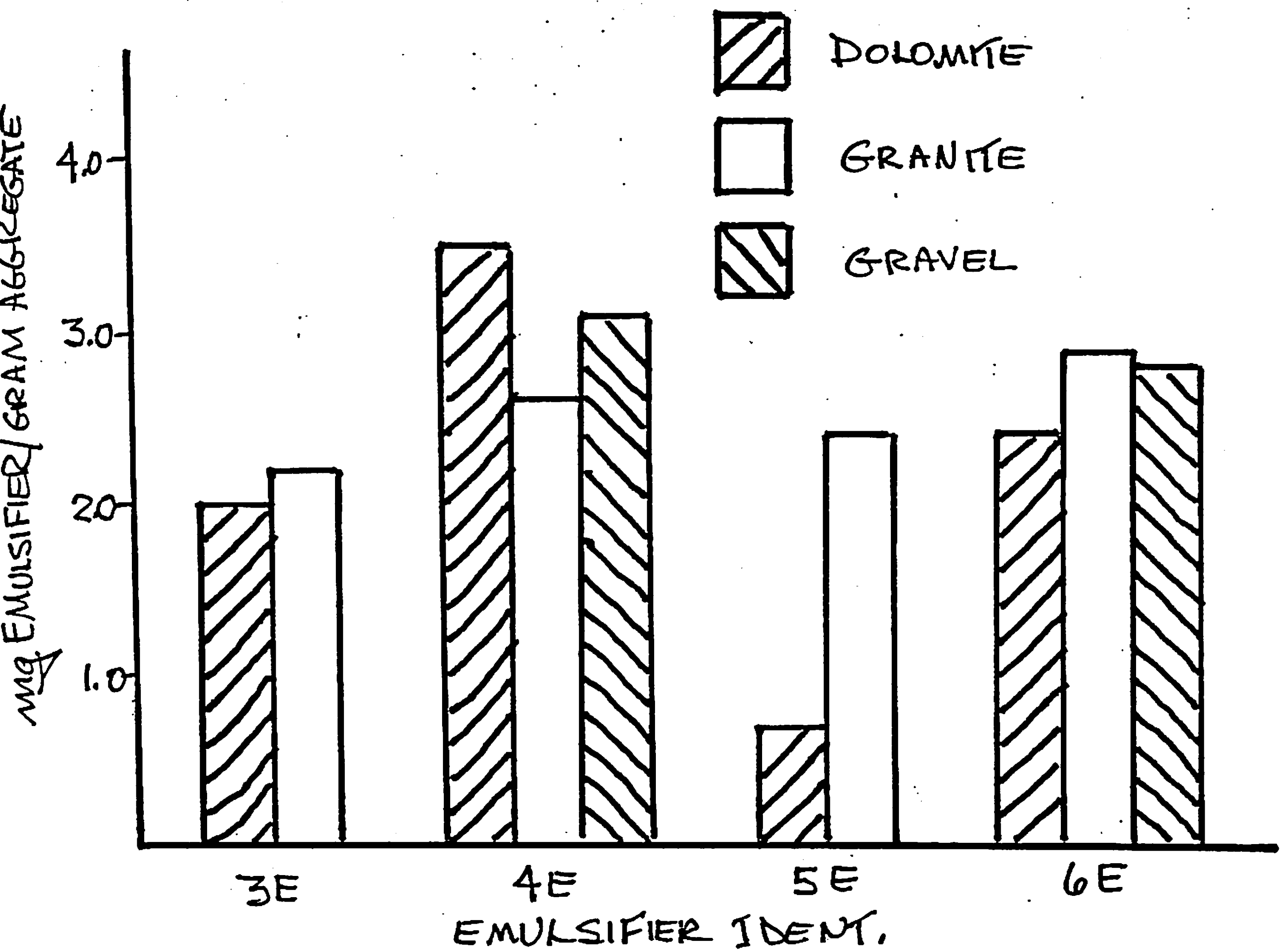


FIGURE 5 EFFECT OF EMULSIFIER TYPE & AGGREGATE TYPE ON EMULSIFIER SORPTION ON TO AGGREGATE SURFACES

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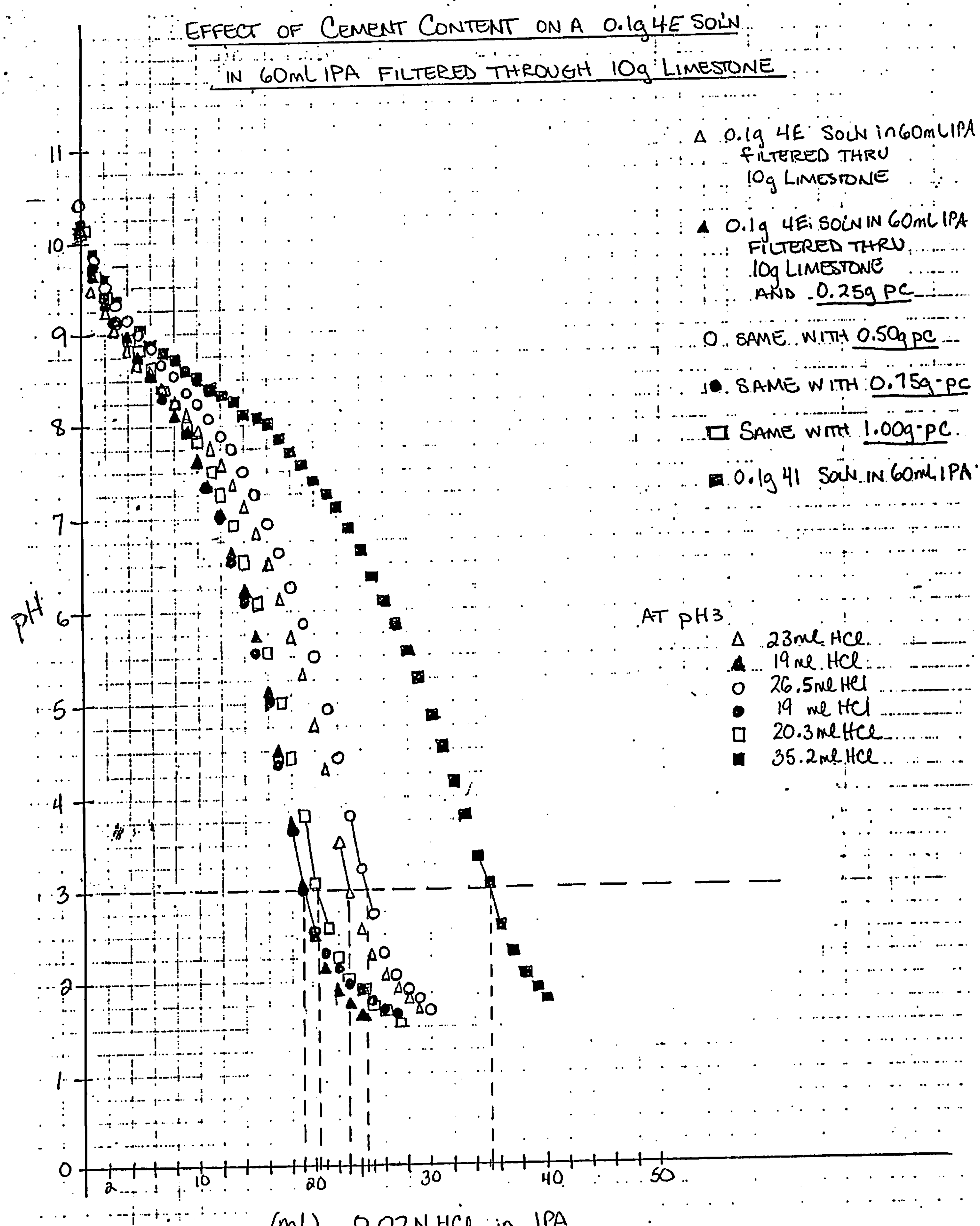

FIGURE 6, EFFECT OF CEMENT

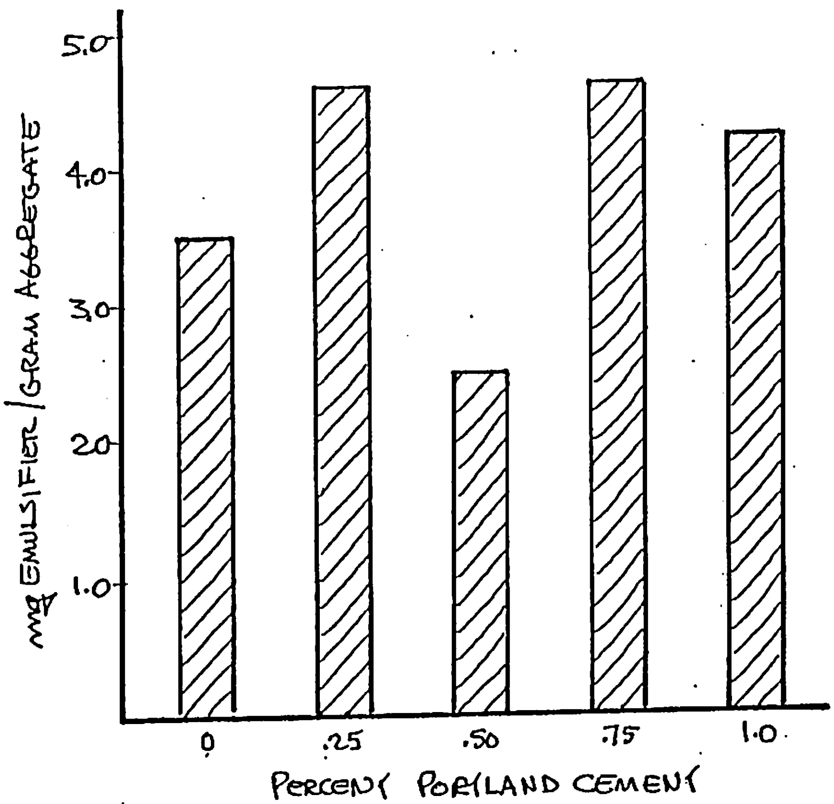

FIG 7. EFFECT OF CEMENT ON EMULSIFIER SORPTION
LATHAM DOLOMITE #30/4,0.4% 4E EMULSIFIER

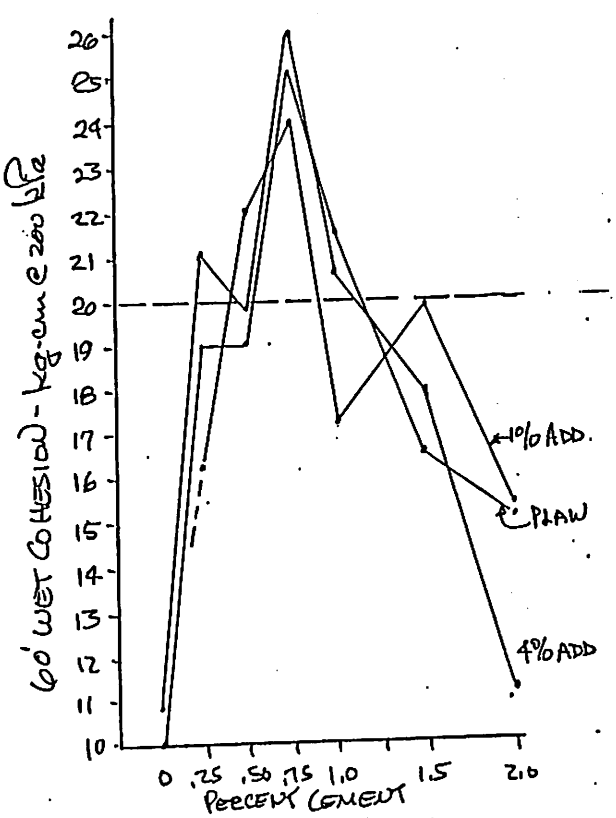

FIG 8

12% 90509-1 (1.2) vs. 0/#4 LATHAM
855GE 1.2mg/g 0/#325 MB.