INSTALLATION AND PERFORMANCE OF LIGHTWEIGHT AGGREGATE ASPHALTIC CONCRETE TEST SECTIONS

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ABSTRACT

In 1966 and 1968 test sections of asphaltic concrete overlays fabricated with coarse lightweight aggregate and fine limestone were installed in the Roanoke-Bedford area. The experimental mixes used were designed in an attempt to develop skid resistant surface mixes for use in predominantly limestone areas. The mixes incorporated 20%— 45% of lightweight aggregate in several different sizes.

The purpose of the test sections was to evaluate the skid resistance and durability of several of the lightweight mixes under field conditions. Skid tests have been performed on the test sections at regular intervals and the results indicate that the mixes are maintaining sufficient skid resistance. This possible alternative method of providing good skid resistant roads in areas lacking polish resistant aggregate might provide significant money savings.

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INTRODUCTION

In the early 1950's, with highways carrying heavier loads and increased traffic volumes, the problem of slick asphaltic pavement caused by aggregate polishing became quite evident(1). Virginia recognized this problem in the Shenandoah Valley region and adjacent areas in which the primary highway aggregates were limestones, many of which polished under traffic.

There have been experiments in Virginia aimed at developing methods of deslicking polished limestone pavements and providing new skid resistant pavements(2). One method used to correct slick pavements was to overlay them with a thin sand mix (25 psy) however, even though the skid resistance was good, some scaling of the mixes was observed. Other experimental mixes were used to help clarify exactly which aggregate components controlled the skid resistance of an asphaltic mix. The addition of fine polish resistant material such as sand to polish susceptible mixes was found to raise the coefficient of friction, but not above the minimum acceptable value. Additional mixes were placed in which some proportion of the coarse aggregate was non-polishing. It was found that if the +4 material was polish resistant then the skid properties were satisfactory. The goal now is to design a surface mix that will maintain a satisfactory coefficient of friction throughout the normal service life of the pavement.

Virginia's present policy for surface mixes is to require 100% skid resistant material for interstate highways and to limit the portion of polish susceptible material for some highways with low traffic volumes. This means that 50%— 100% of the aggregate for surface mixes in many limestone areas must be trucked in from distant sources and the resulting mix cost is necessarily higher than when using local materials. Alternate mixes providing adequate skid resistance may prove economically advantageous in certain areas.

A material that has shown promising skid resistance qualities in Louisiana is lightweight aggregate(3). In the Virginia experiments, pavements constructed of combinations of coarse lightweight aggregate and fine limestone have been constructed and tested, and partial results are presented in this report.

PURPOSE AND SCOPE

The purpose of this project was to evaluate the durability and skid resistance of several test sections containing lightweight coarse aggregates and limestone fines. The test sections, placed in August 1966 and October 1968, utilized weblite (expanded clay) and solite (expanded shale) respectively. Skid tests have been run on the sections at regular intervals in order to determine their initial resistance and the rate at which it might diminish.

EXPERIMENTAL TEST SECTIONS

Two experimental test sections have been constructed utilizing lightweight aggregates blended with limestone aggregate. In 1966 a test section was laid comprised of four mixes with different sizes and percentages of lightweight aggregates. In 1968 a second test section was constructed with five mixes containing different sizes and percentages of lightweight aggregate.

1966 Installation

In August 1966 a 2500' test section was installed on the EBL of Route 460 West of Bedford, Virginia (Figure 1*). Four mixes were employed. These contained different proportions of limestone screenings (-#10 material), 3/4" weblite and 5/16" - 3/16" weblite. Table I lists the material gradations and the intended and actual mix proportions. The percentage of lightweight aggregate in the pavement was determined by submerging in an acid solution a sample of mixture from which the bitumen had been extracted. The acid dissolved the limestone and left the lightweight aggregate.

The percentage of limestone screenings was varied from 57% to 80% and the asphalt content from 7.0% to 8.1%. The purpose of making mixes with different limestone contents was to determine the minimum amount of lightweight aggregate that would provide acceptable skid resistance.

The mix was placed with a standard paver. The only particular construction problem was dragging of the mix due to some particles being larger than the applied thickness. This problem is readily solved by decreasing the maximum particle size or increasing the thickness.

1968 Installation

In October 1968 a two mile test section was installed on the SBL of Route 220 south of Roanoke (Figure 2). Attempts were made at the plant to make five different mixes;

*All figures and tables are appended.

however, from the mix analyses it was found that some of the mixes were nearly duplicated in limestone content. Table II lists the gradations of the three sizes of solite materials (3/4" - #4, 3/8" - #8, 3/8" - 0) and that of the limestone screenings, and also gives the actual limestone content, asphalt content, and gradation of each mix.

The mixes ranged in gradation from a coarse mix with the 3/4" - #4 solite to a fine mix with the 3/8" - 0 solite. The asphalt content was varied from 6.6% to 8.0% for the 3/4" - #4 and 3/8" - 0 solite respectively. The maximum and minimum limestone contents were 82% and 55% respectively.

SKID TEST RESULTS

The test section on Route 460 has been under traffic for approximately four years and the one on Route 220 for approximately two years. Skid tests have been performed at regular intervals on both installations in order to evaluate the susceptibility of the pavements to polishing. All mixes on the Route 460 section have maintained skid numbers above 40 (40 is considered the minimum acceptable skid number for this type highway). Figure 3 illustrates the measured skid numbers on the individual mixes and shows the change of skid number due to traffic wear. The approximate cumulative total traffic count and trailer truck traffic are also indicated so that they may be compared with those on the Route 220 test section.

Mix No. 2 is in both the traffic lane and the passing lane, and the skid test results indicate that a higher coefficient of friction has been maintained in the passing lane, which carries less traffic. These results are as they should be.

The effect of limestone content can be examined by comparing mixes 1 and 2, both which are in the passing lane. Mix no. 1 (57% limestone) has maintained a slightly higher skid number than mix no. 2 (80% limestone) but is not clear whether this is the result of less limestone.

Mixes 3 and 4 both had 71% limestone, and the skid numbers are nearly equivalent now at about 55.

Most mixes show a decrease in skid number, followed by a slight increase. One explanation for this may be that initially more limestone particles are exposed to the tire surface so that polishing occurs. As the limestone particles are worn down, more and more lightweight aggregate particles are exposed to the tire surface and the skid coefficie increases.

The test section on Route 220 has been under traffic for only approximately two years so there is not as much skid test information available on it as there is on the Route 460 section. The traffic volume is somewhat greater on Route 220 than on Route 46 and in two years Route 220 has carried approximately two-thirds the total truck traffic that Route 460 has carried in four.

442 In general the skid numbers are lower on Route 220 than on Route 460 section. The mixes in the Route 220 traffic lane had skid numbers of approximately 45 at last test, which was made in May. If the skid numbers of these mixes now increase as it appeared those on the Route 460 test section did under a similar traffic count, then they may not drop below 40. If the downward trend continues then it is quite possible that some of the Route 220 mixes in the traffic lane will go below the minimum skid number of 40.

The durability of both test sections appears to be adequate and comparable to that of conventional designs.

CONCLUSIONS AND RECOMMENDATIONS

No definite conclusions can be drawn at this time since the minimum skid coefficient of the test sections may not have been reached. The skid numbers are still above 40, which is the minimum acceptable. The trend of the test results from the Route 460 test section indicates that the drop of skid resistance caused by traffic wear has stopped and the roadway is maintaining an acceptable level of friction. Additiona skid tests on the Route 220 test section will indicate if it will drop below the acceptable skid number of 40.

It is recommended and anticipated that these sections and additional test sections containing limestone and lightweight aggregate will continue to be tested with the skid trailer at regular intervals to determine their performance with regard to polishing.

REFERENCES

1. Dillard, J.H., and R. L. Alwood, "Providing Skid-Resistant Roads in Virginia", Proc. of Association of Asphalt Paving Technologists, Vol. 26, (1957).

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3. Arena, Philip J., Jr., "Expanded Clay Hot Mix Study", presented at the Annual Meeting of the Association of Asphalt Paving Technologists, Kansas City, Missouri, February 9-11, 1970.

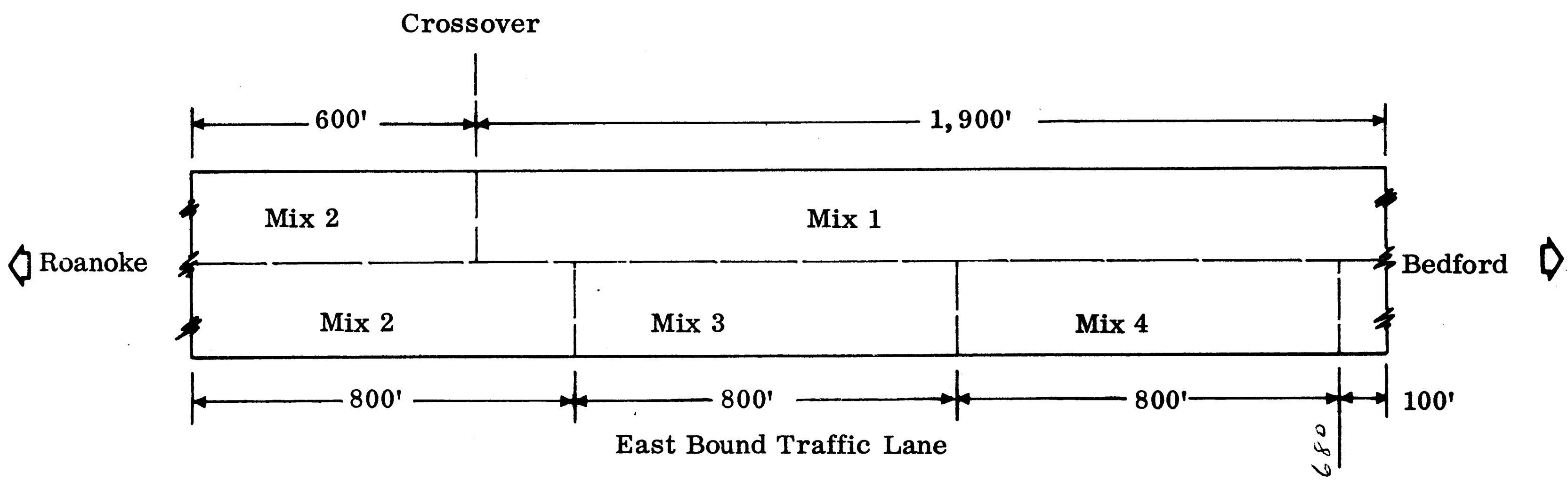

Figure 1. Location of Weblite test sections — Rte. 460 — Bedford County.

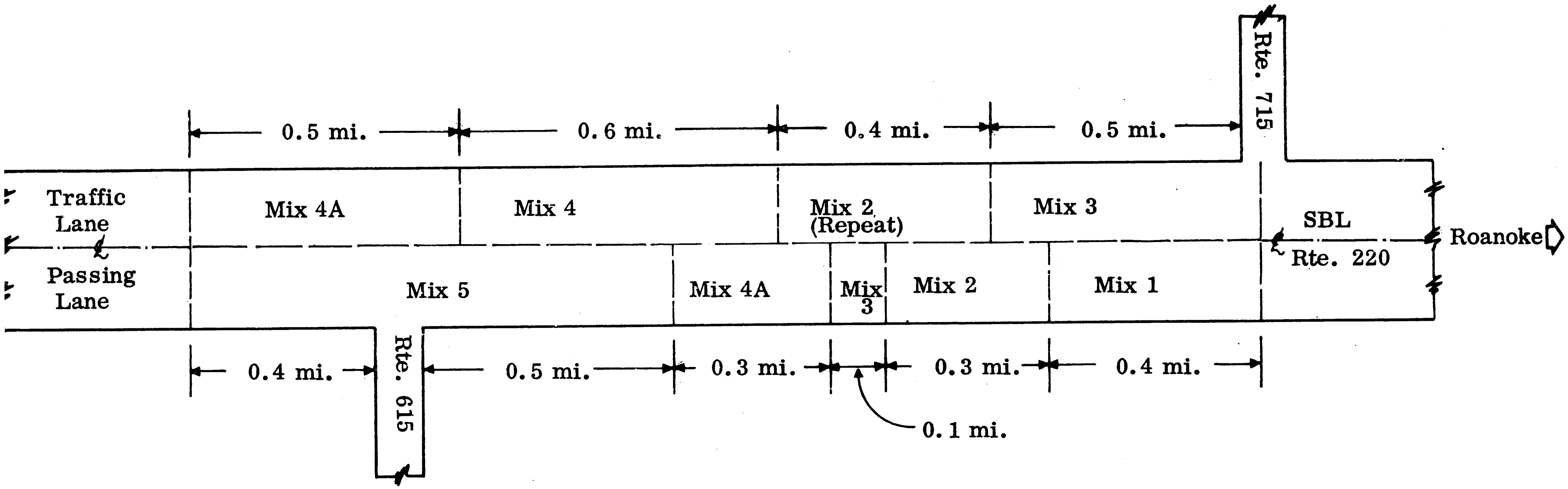

Figure 2. Location of Solite test sections — Route 220 — Roanoke County.

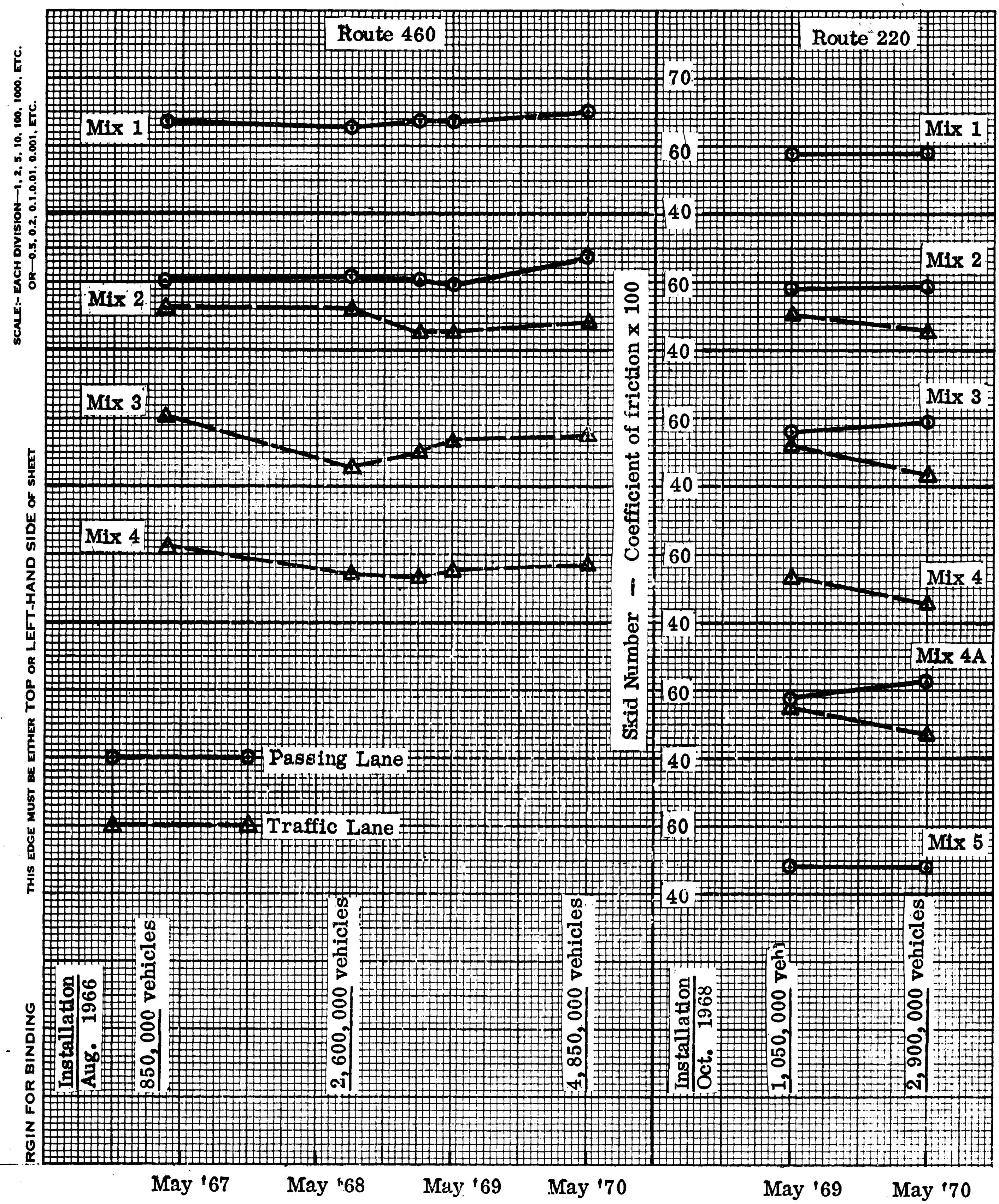

Figure 3. Skid test results on Routes 220 & 460.

TABLE I

LAB ANALYSIS OF WEBLITE EXPERIMENTAL SAMPLES

Materials	3/4" Weblite	5/16" - 3/16" Weblite	Limestone Screenings	Limestone 5/16" - 3/16" Weblite		20% 3/4" Weblite 20% 5/16" x 3/16' 60% Limestone	
Mix No.				1	2	3	4
% Passing							
1"							
3/4"	100.0					100.0	100.
1/2"	86.1	100.0			100.0	97.7	97.
3/8"	49.6	99.7	100.0	100.0	99.9	94.7	94.
4	2.9	20.2	98.5	85.2	93.8	81.9	80.
8	2.4	2.4	81.1	65.2	76.6	67.7	65.
30	2.1	2.2	39.2	21.5	26.7	24.4	24.
50	1.9	2.1	27.6	11.6	14.7	13.9	13.
100	1.6	2.0	18.9	6.0	7.6	7.8	7.
200	1.2	1.7	13.6	3.9	5.1	5.5	4.
% A.C.				8.1	7.9	8.1	7.
% Limestone				57	80	71	71
% Weblite				43	20	29	29

LAB ANALYSIS OF SOLITE EXPERIMENTAL SAMPLES

Materials	3/4" - #4 Solite	3/8" - #8 Solite	3/8" - 0 Solite	Limestone	Limestone and 3/4-4 Solite				Limestone and 3/8-8 Solite		Limestone and 3/8-0 Solite
Mix No.					Mix #1	Mix #2	Mix #2 (Repeat)	Mix #3	Mix #4	Mix #4A	Mix #5
% Passing											
+1					100.0	100.0		100.0			
+3/4	100	100			97.3	98.8	100.0	99.6		100.0	
+1/2	70	90			87.9	93.1	93.7	93.5	100.0	99.1	
+3/8	40	40	100		78.4	88.2	87.0	88.8	99.9	98.6	100.0
+4	5	15	85	100	67.7	76.7	77.9	81.6	85.3	88.1	93.2
+8			65	97	53.8	60.9	55.9	58.9	55.8	61.9	66.3
+30			25	34	17.6	25.7	18.4	21.2	18.7	22.3	21.8
+50			15	17	10.9	18.2	11.8	14.8	12.1	15.0	14.0
+100			10	12	7.5	14.0	8.4	11.2	8.8	11.1	10.1
+200				8	5.6	11.3	6.5	9.2	7.2	9.0	8.0
% A. C.					7.1	6.8	6.2	6.6	7.8	8.0	8.0
% Limestone					55	61	79	79	73	82	76
% Solite					45	39	21	21	27	18	24