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C.A. Frazier

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Introduction

The current accelerated pace of highway construction in the United States has presented many problems to those engaged in various fields of endeavor. Not the least of these problems is the acquisition of enormous quantities of suitable aggregates to supply an ever increasing demand. Coupled with the rapid depletion of sources known to contain quality material is the need for more rapid tests to determine the acceptability of aggregates from virgin sources. The time required and the cost of testing these materials has aroused nationwide interest.

The purpose of subject project was to determine if the durability test recently developed by this department could be used to predict the sodium sulfate soundness of P.C.C. sands. The durability index of a P.C.C. sand can be determined within two hours after completion of the sieve analysis test and requires no specialized equipment. In comparison, the sodium sulfate soundness test requires seven working days to complete, must be performed under closely controlled atmospheric conditions and requires special equipment including temperature controlled solution tanks. Although the costly and time-consuming soundness test using Sodium or Magnesium Sulfate has for many years been a universal standard method, it is readily apparent that any significant reduction in the number of tests performed would result in a savings of several thousands of dollars annually.

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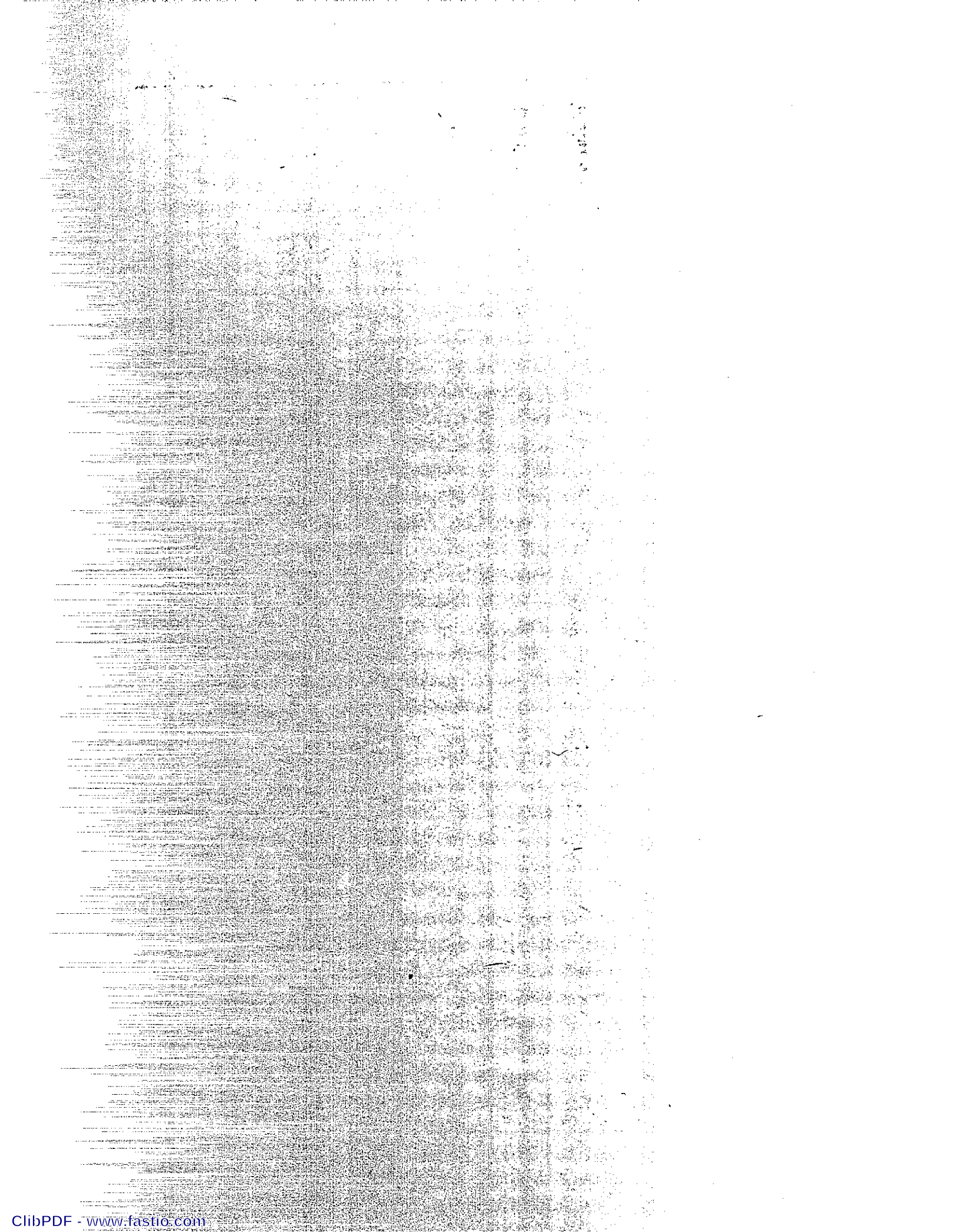

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State of California
Department of Public Works
Division of Highways
Materials and Research Department

May 25, 1965

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Exp. Auth. 451148

Mr. L. R. Gillis
Asst. State Highway Engineer
Division of Highways
Sacramento, California

Dear Sir:

Submitted for your consideration and approval is the

FINAL REPORT

on

CORRELATION OF SODIUM SULFATE SOUNDNESS TEST

with

DURABILITY INDEX OF CONCRETE SANDS

Study made by ..... Foundation Section
Under general direction of ..... Travis Smith
D. L. Spellman
Work supervised by ..... C. A. Frazier
Report prepared by ..... C. A. Frazier

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

Attach
cc:GAHill-3:LR Gillis
DLSpellman:TWSmith
Research Files

Introduction

The current accelerated pace of highway construction in the United States has presented many problems to those engaged in various fields of endeavor. Not the least of these problems is the acquisition of enormous quantities of suitable aggregates to supply an ever increasing demand. Coupled with the rapid depletion of sources known to contain quality material is the need for more rapid tests to determine the acceptability of aggregates from virgin sources. The time required and the cost of testing these materials has aroused nationwide interest.

The purpose of subject project was to determine if the durability test recently developed by this department could be used to predict the sodium sulfate soundness of P.C.C. sands. The durability index of a P.C.C. sand can be determined within two hours after completion of the sieve analysis test and requires no specialized equipment. In comparison, the sodium sulfate soundness test requires seven working days to complete, must be performed under closely controlled atmospheric conditions and requires special equipment including temperature controlled solution tanks. Although the costly and time-consuming soundness test using Sodium or Magnesium Sulfate has for many years been a universal standard method, it is readily apparent that any significant reduction in the number of tests performed would result in a savings of several thousands of dollars annually.

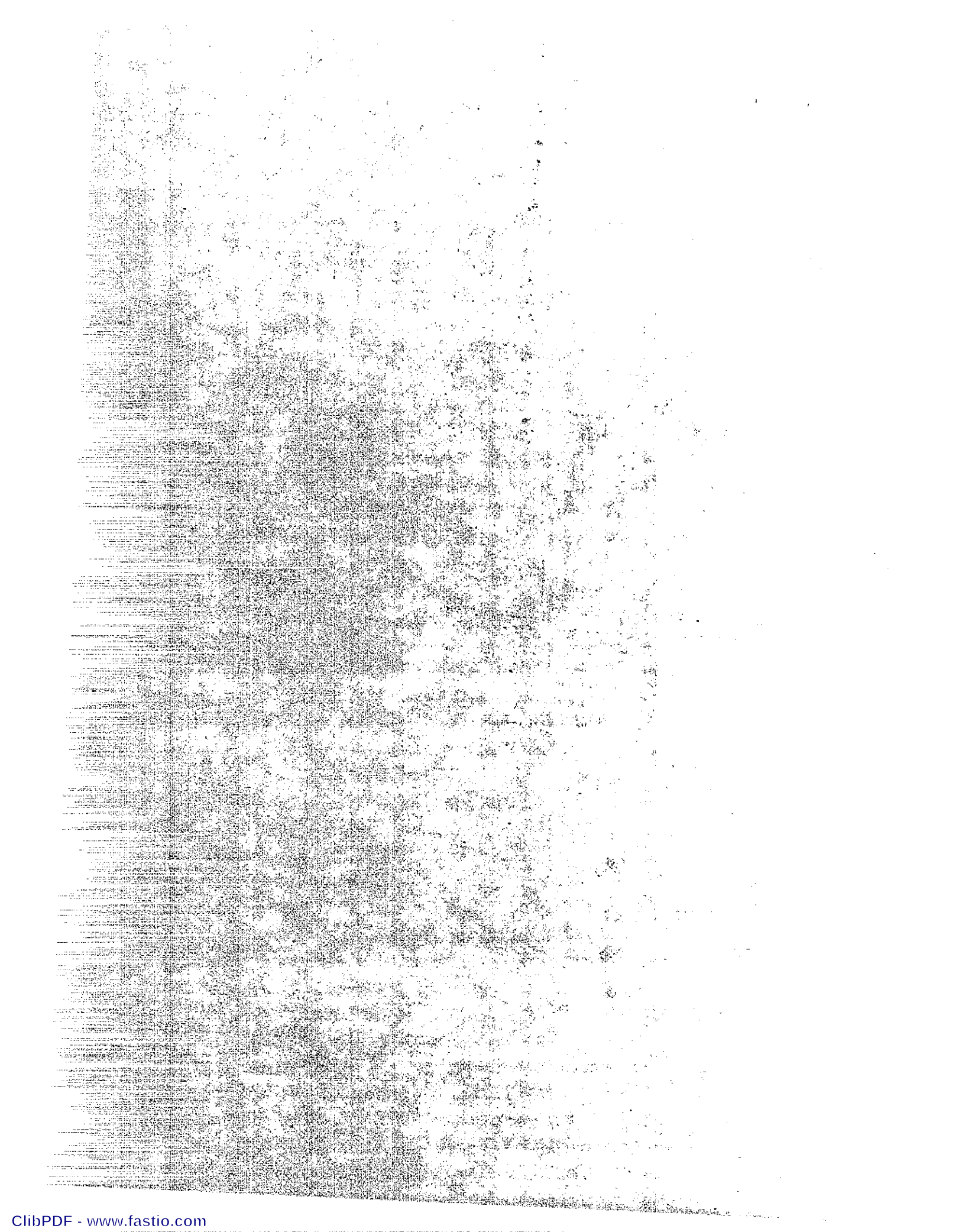
Conclusions

Comparison of Durability Index with percent loss on the Sodium Sulfate Soundness Test on 425 P.C.C. sands and other fine aggregates, as shown in Figure 1, indicates the following:

1. The percent loss in the Na_2SO_4 Test tends to increase as corresponding Durability Index values decrease.

2. Of those samples tested having a durability index greater than 50, only 1.5% exceed eight percent loss in the Soundness Test with none exceeding ten percent loss. Visual inspection of the data indicates the envelope of extreme values would cross the 10% soundness loss at a durability index of 60.

Based on the data presented in this report, samples of P.C.C. fine aggregate having a durability index of 60 or greater will not be tested for percent loss in the Sodium Sulfate Soundness Test. In lieu of reporting soundness test results, a comment is being entered on the test report stating that the durability index on the material indicates that it will comply with the Sodium Sulfate Test requirements. A standard special provision is being prepared waiving the soundness test requirement on P.C.C. fine aggregate provided the material has a durability index of not less than 60. About 80 percent of the concrete sand samples now being tested fall into this category.



It is felt that the results of this investigation and consideration of the reproducibility of the durability and soundness tests provide substantial assurance that no relaxation of quality requirements will be effected by this change. It is estimated that this recommended procedure will result in a potential net annual savings of $9000 in testing charges.

Testing and Analysis of Data

All data accumulated for analysis under this project consisted of results of routine tests performed on samples received by this department from many commercial aggregate sources.

The initial phase of this project consisted of determining the durability index of approximately 80 samples of P.C.C. fine aggregate which had previously been tested for percent loss in the Sodium Sulfate Soundness Test. The comparison of values obtained from these tests indicated a possibility that some relationship did exist.

In order to determine the degree of relationship, durability index tests were performed on State-wide incoming samples of P.C.C. fine aggregate and these results were compared with the soundness test results on the same material. A total of 401 comparisons of results on P.C.C. fine aggregate were made for this investigation. The other 24 comparisons shown in Figure 1 are results of tests performed on the fine aggregate portion from materials intended for use in other than portland cement concrete. All of these materials had durability indexes of less than 50 and generally had greater than 10% loss in the soundness test.

Concurrent with the collection of data for this study, the Relative Mortar Strength and other test data was also tabulated. From this information a plot of durability index vs. relative mortar strength was made as shown in Figure 2. Since no apparent correlation existed between these two tests, even considering other factors such as absorption and sand equivalent, this part of the study was discontinued. Changes in the mortar test method are now being considered and perhaps a new test for sands will make it possible to similarly screen sands for mortar tests.

STATE OF CALIFORNIA
HIGHWAY TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

FINAL REPORT

on the

65-40

February, 1965

State of California

Memorandum

Date: February 24, 1965

To : Mr. George A. Hill
Asst. State Highway Engineer - Planning

File :

From : Department of Public Works—Division of Highways
Materials and Research Department

Subject: Final Report on Materials and Research Project No. 24030

Attached for your consideration and approval are three copies of the Final Report dated February 19, 1965, on our Project Authorization No. 24030-R, "Development of a Proportional, Rotary-type Fine Aggregate Splitter."

Original Signed
JOHN L. BEATON

JOHN L. BEATON
Materials and Research Engineer

CAF:ml
Attach

Approval Recommended

3/10/65

Orig Signed L. R. Gillis

L. R. Gillis
Asst. State Highway Engineer

M E M O R A N D U M

TO: John L. Beaton

February 19, 1965

FROM: Travis Smith

SUBJECT: Final Report on Project Authorization 24030-R, Development of a Proportional, Rotary-type Fine Aggregate Splitter.

INTRODUCTION

In 1952, under the direction of Mr. F. N. Hveem, work was started on the development of a rotary-type fine aggregate splitter. This splitter was designed to separate a predetermined portion of a sample into four separate representative specimens in one operation.

On April 13, 1953, a report was submitted by H. R. Richard on the calibration and operational characteristics of the unit. A report dated July 2, 1953 was submitted by Mr. Richard covering the results of a series of trials using the Hveem Mechanical Quartering Machine on various types of materials. Comparisons of the relative performance of this unit and other splitting methods were reported by Mr. Richard on October 22, 1953. Research Authorization Number 2030 (later changed to 24030) was issued on February 9, 1954 to "Design and Construct a Sample Splitter" suitable for the preparation of R-value test specimens.

After making minor changes to reduce the objectionable noise caused by operating the unit, the splitter was sent to the Dist. 06 Materials Department. The District 06 Materials Department felt, after seven months in-use experience with the revolving splitter, that the unit was very reliable and had many advantages over conventional methods of splitting. (See letter, E. O. Hoakanson, Acting District Materials Engineer, to F. N. Hveem, Attention of A. W. Root dated March 15, 1957.)

Early in 1963, the revolving splitter was temporarily returned to Sacramento for preparation of "as-built" drawings. Using the first unit as a basis, rotary splitter No. 2 was designed incorporating several new features. Initial construction of the revised rotary splitter was completed and delivered to the R-value unit during the summer of 1964.

The development and operation of rotary splitter number 2 and a performance evaluation made in 1963 on the unit used by District 06 is submitted in this report.

CONCLUSIONS

1. Results of the 1963 performance evaluation made on the first rotary splitter disclosed several operational deficiencies. Although some of these deficiencies could be corrected, correction of some characteristics of the unit would require a change in design.

2. Experience gained in the use of rotary splitter number 2 indicated that it possibly could be developed into a very satisfactory laboratory tool. The advantages of this rotary splitter over the conventional riffle unit are small, however. This is especially true when viewed in the light of the substantially greater cost and size of the rotary splitter.

RECOMMENDATIONS AND ACTION TAKEN

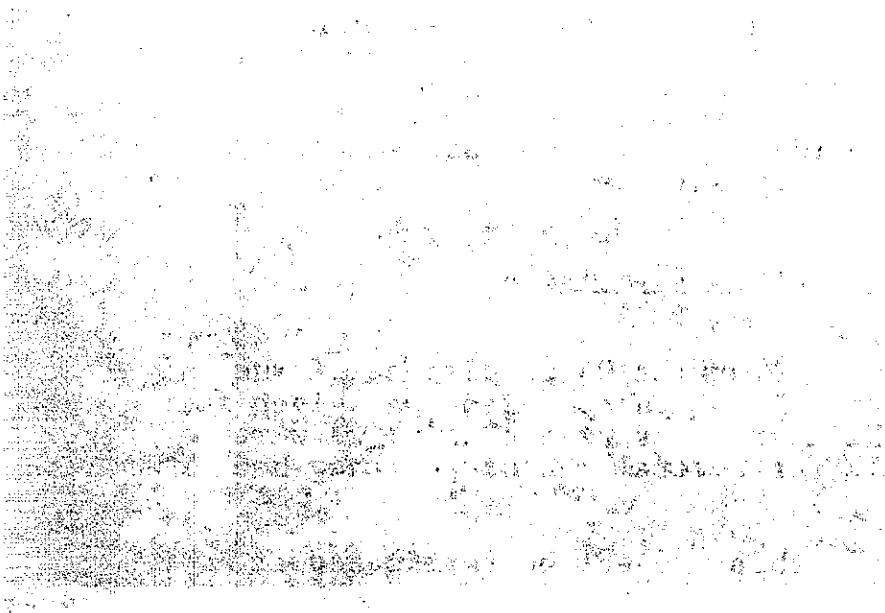
1. Permission was given to District 06 to dispose of the rotary splitter loaned to them. Although no reason was given for their change in opinion on the usefulness of the unit, we were informed that it has been idle for several months and they had no further need for it.

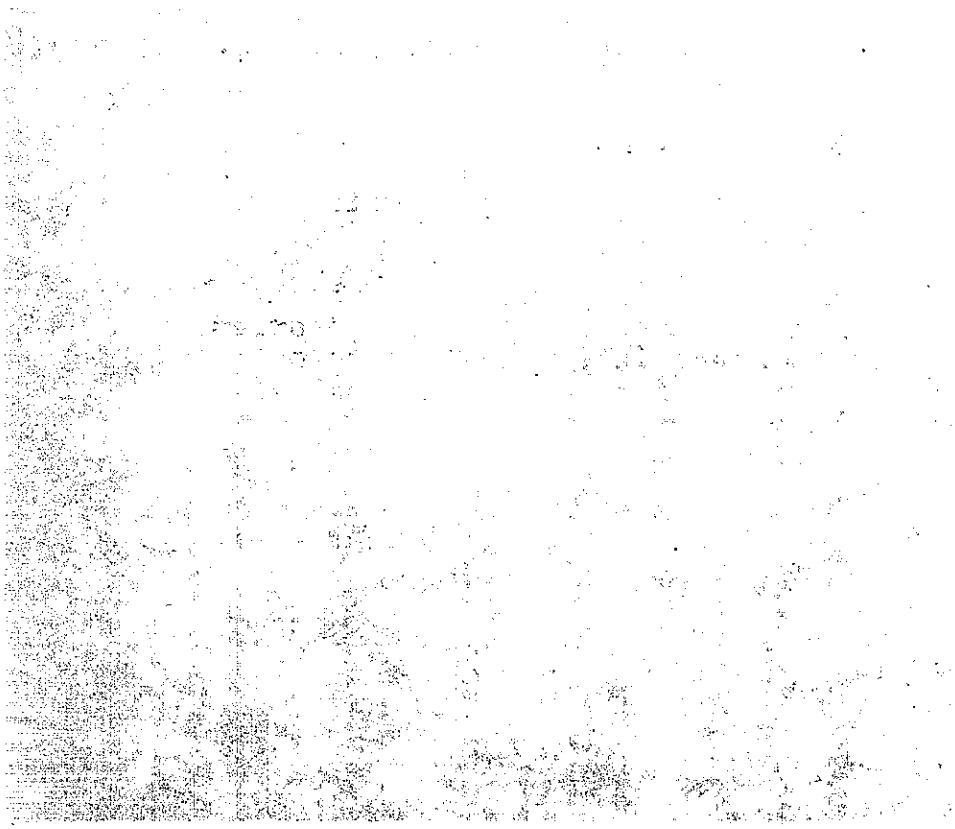
2. It is recommended that this project be terminated at this time for the following reasons:

a. Tests performed after each series of modifications to the unit indicate that further modifications are necessary. Continuing this cycle of events is not only costly but appears to be unrewarding.

b. Although a rotary splitter of this type would have certain advantages over the Jones type riffle splitter, the substantially greater cost and size of a rotary unit would limit its acceptance and use.

c. If a rotary splitter were adopted as a standard item of laboratory equipment for the district laboratories, city and county laboratories might feel compelled to obtain this item to comply with test requirements. The cost of a rotary splitter would be burdensome to them.





PERFORMANCE EVALUATION-ROTARY SPLITTER NUMBER 1

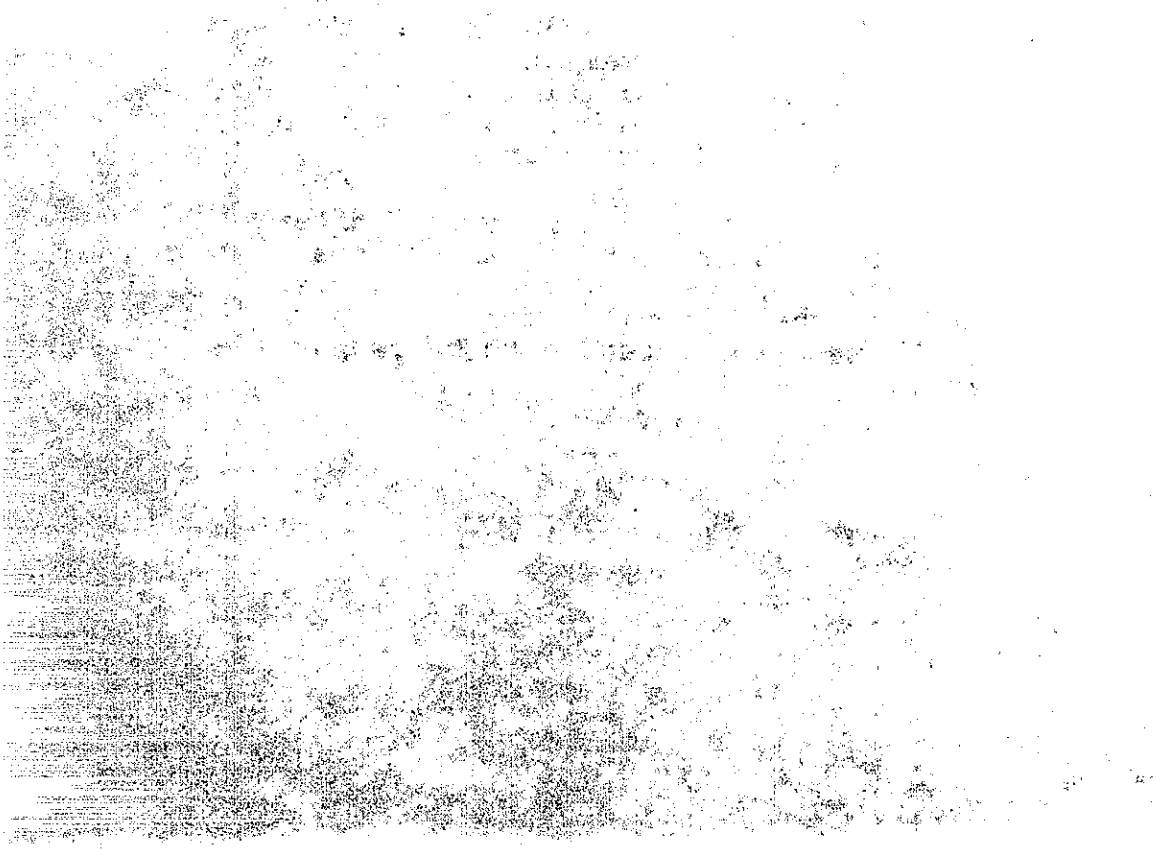
A series of tests was performed on this unit during the month of March, 1963. Four samples, each weighing 13,000 grams or more were split in this rotary splitter with the adjustment lever set to obtain 1000-gram portions in each of four pans. Two additional passes through the splitter were made with each sample using the material caught in the waste pan from the previous pass, (a slight adjustment was made to the weight of sample 1 before the third trial). All of these samples had 100 % passing No. 4 sieve material and the following:

Sample	1	2	3	4
% pass #30 sieve	43	38	48	47
% pass #200 sieve	4	11	21	23

In addition to the above, two samples of P.C.C. Sand, each weighing 10,000 grams, were split once with the adjustment lever set to obtain four 1000-gram portions.

The test data obtained from this series of tests is attached. Note that, although the adjustment lever was set to obtain 4000 grams total on each trial, the total weight in the four pans varied from 2644 grams to 4432 grams. The adjustment scale used to set the desired weight of material was in poor condition and settings were very critical. It was extremely difficult to set the adjustment to obtain an average weight in each pan to the nearest $\pm$ 100 grams or 10%.

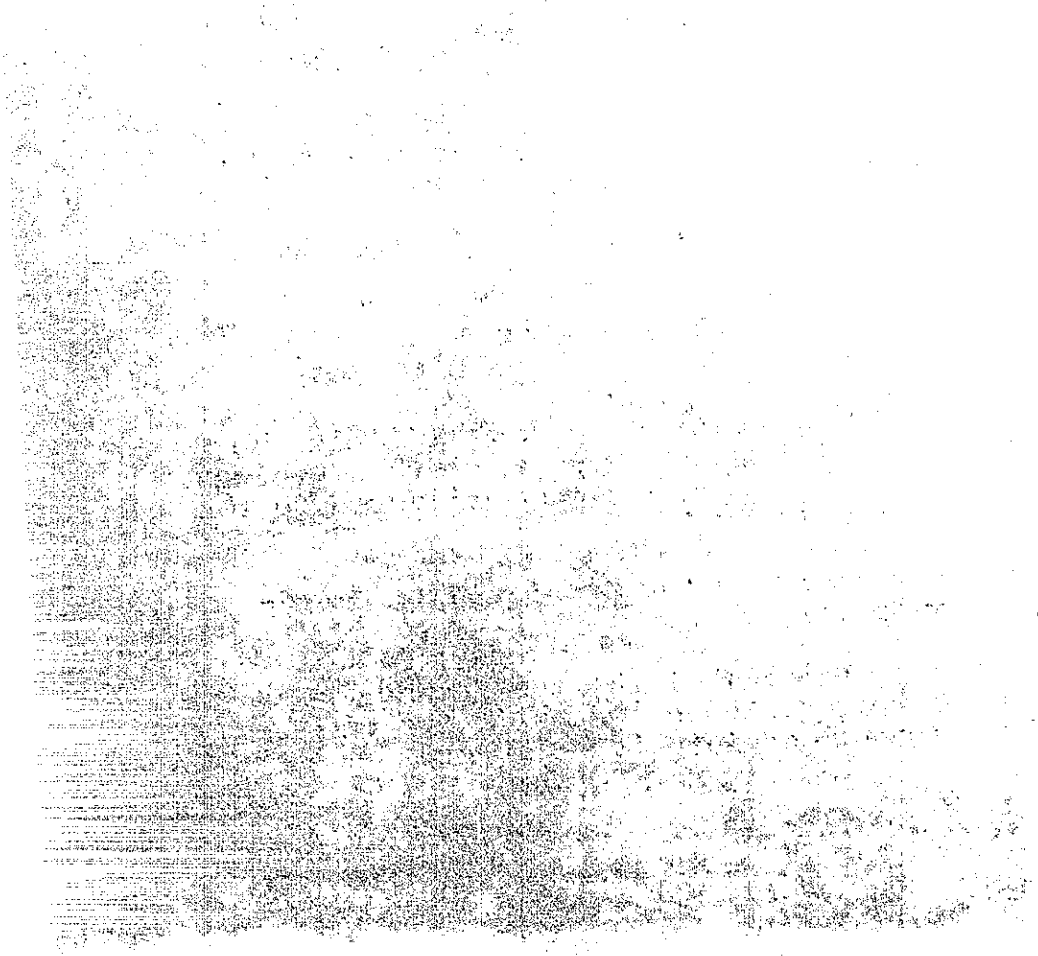
Not all of the material being split was recovered after passing through this unit. The 0.5% to 3.0% shown as loss on the attached tabulation represents the amount of material spilled onto the floor and the shelf provided for the "waste" pan. Apparently none of the material intended to be caught by the sample pans was lost.



Considerable variation in weights of material caught by each pan were noted. As can be seen in the attached tabulation, the percentage deviation from the average weights are not constant for each pan but vary according to the total weight of sample being split. The average deviations for each pan are as follows:

Total Weight of Sample-grams	Avg. % Deviation from Avg. Weight Pan No.			
	1	2	3	4
5,001 - 7,500	+0.1	-1.3	+1.0	+0.3
7,501 - 10,000	-2.5	-0.8	+3.1	+0.2
10,001 - 12,500	-6.9	+0.5	+6.7	-0.4
12,501 - 15,000	-7.6	+0.5	+8.0	-0.9

Although grading analyses were performed on a portion of one sample obtained after each pass through the unit, the data was inconclusive. In general, gradings checked within $\pm$ 4 percentage points on the coarser screen sizes with one 6 point and one 8 point deviation. The greatest variances in grading analyses were noted on the Nos. 8 and 16 sieves with no greater than $\pm$ 2 points on the No. 200 sieve. No assurance can be given that these variances were caused by the revolving splitter since the test sample was subsequently reduced using a riffle splitter before performing the grading analysis.



DEVELOPMENT OF ROTARY SPLITTER NUMBER 2

The Rotary Splitter under discussion was of quite a different design from the earlier unit which is now in use at District 06, because the rotating table proportional feeder for the incoming sample was eliminated in favor of a Syntron vibrating feeder. In addition, six V-shaped hoppers were positioned in a six-pointed star arrangement in lieu of four to reduce the incoming 40 or 50 pound samples down to six 1,000 gram lots,-- and on two of these V-hoppers, two additional sub-splitters were arranged to take the 1,000 gram lots on down to 250 grams each.

After initial trials, the entire unit was raised to make the split sample removal more accessible. The Syntron was replaced with a hopper feed as the Syntron was found to seggregate the coarser fractions from the fine materials. This hopper was mounted on a pneumatic lift which eliminated the need of the operator lifting the initial samples.

Other improvements were made or suggested on lesser details as noted below, but the unit was never particularly popular with the operators as they could see no specific advantage of using it. It represented no space saving or time saving advantage over the standard riffle splitters.

The following features were added to this unit during the developmental stages:

1. Installed over-ride clutch on splitter drive to permit hand rotation for inspection and removal of samples.
2. Added sample lift for feed hopper to prevent lifting of sample.
3. Epoxy 60° corners to proportioning splitter hoppers to give radius to prevent dust hold up or bridging.
4. Dump reject directly into waste bag.

OPERATION-REVOLVING SPLITTER NUMBER 2

Trial tests, performed while the splitter was still in the machine shop, indicated some problems in clogging of the openings. This was partially corrected before the unit was delivered to the R-value batch room in the summer of 1964.

The following items were noted by the R-value unit during the trial period using this splitter:

1. Clogging necessitated removal of the two secondary units. These units were intended to split two of the six 1,000-gram portions into four 250-gram units each.

2. An accurate calibrated scale for adjusting the splitter is needed. The present method of adjustment is too critical to obtain portions of predetermined weight within acceptable limits.

3. The present feed hopper does not permit uniform flow of damp material into the rotary assembly.

4. Uniformity in size of test samples is poor. Because of this final adjustment using a riffle splitter is frequently necessary.

Additional improvements considered but not provided were as follows:

1. Enclosure of entire unit to restrict airborne dust.

2. Seal chain drive to rotary assembly from dust.

3. Investigate anti-static plastic coatings to eliminate dust retention on chutes.

4. Use of standard stock pans to receive split samples.

5. Add sequence timer for automatic operation.

Travis Smith

Travis Smith
Assistant Materials and
Research Engineer - Foundation

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S McCloy

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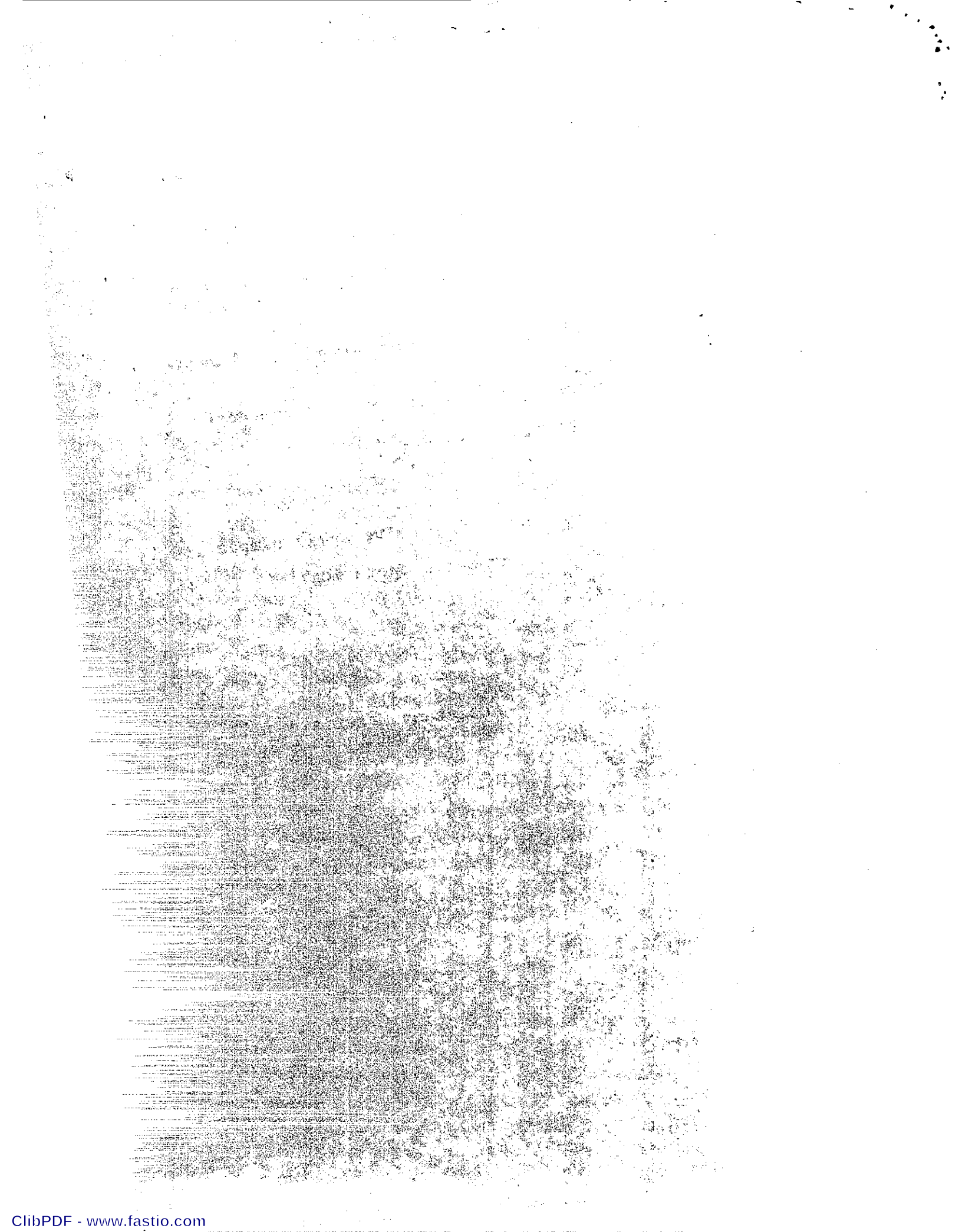

TEST DATA-REVOLVING SPLITTER NO. 1

Sample	Trial	Total Wt.	Grams Retained Pans	Grams Retained Waste	Loss	% Loss	Avg. wt. Pans	% Deviation from Avg. Pan No. 1	2	3	4
1	A	13,000	3642	8,965	393	3.0	910	-6.9	+0.9	+7.1	-1.1
	B	8,965	4432	4,428	105	1.2	1108	-0.9	+0.9	+2.3	-0.5
	C	5,005	4273	699	33	0.7	1068	+0.3	-0.2	+0.5	-0.6
2	A	13,390	2893	10,329	168	1.3	723	-8.6	0.0	+8.9	-0.3
	B	10,329	3307	6,917	105	1.0	827	-6.9	+0.6	+6.6	-0.3
	C	6,917	3837	3,014	66	1.0	959	+0.1	-3.3	+1.9	+1.3
3	A	14,320	2930	11,220	170	1.2	732	-8.1	+1.0	+8.3	-1.2
	B	11,220	2644	8,488	88	0.8	661	-7.6	+0.5	+7.3	-0.2
	C	8,488	4231	4,216	41	0.5	1058	-0.5	-1.3	+1.6	+0.2
4	A	13,980	3317	10,521	142	1.0	829	-6.8	0.0	+7.8	-1.0
	B	10,521	3431	7,002	88	0.8	858	-6.1	+0.5	+6.2	-0.6
	C	7,002	3796	3,171	35	0.5	949	-0.2	-0.5	+0.6	+0.1
5		10,000	3858	6,085	61	0.6	964	-4.7	-0.6	+4.2	+1.1
6		10,000	3801	6,072	127	1.3	950	-4.0	-0.2	+4.4	-0.2