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16. Abstract

This study evaluated the Chace Air Indicator (CAI) using sixteen concrete mix variables and has provided results conforming with the findings of previous research. The CAI indicated higher values than the pressure method at low air contents and lower values at high air contents. However, mortar-corrected CAI readings, using the proper Chace factor, gave values typically 15 percent higher than the pressure method over all ranges of air contents. A set of curve correction equations with confidence intervals indicating the reliability of results was suggested to adjust for deviations with results based on the average of one, two or three readings per test sample.

It is concluded that the performance of the CAI improves with increased number of readings per test sample and proper training of operators.

It is recommended that the CAI be used with care in testing concretes with high range water reducer at high air contents because of the variation of readings with time.

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by

Mazen Jabri
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Alvin H. Meyer

Research Report Number 363-1

Research Project 3-9-83-363

conducted for

State Department of Highways and Public Transportation

in cooperation with the

U.S. Department of Transportation
Federal Highway Administration

by the

CENTER FOR TRANSPORTATION RESEARCH
THE UNIVERSITY OF TEXAS AT AUSTIN

August 1984

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

PREFACE

This study was made possible by the excellent cooperation of many people in the Department: Billy R. Neeley, William E. Elmore, Fred Schindler, Clarence Rea, and Kenneth R. Sandberg, D-9: Berry R. English, D-5; Wayne Chambers, D-6; Richard Wesson, Jr., Mack Grimes, William Beaver and James A. Kirk, District 14; Dick Magers, District 15; Charles H. Little, District 16; and R.A. Vansickle, Houston Urban District.

The representatives were extremely helpful in assisting us formulating the tasks and in presenting the information. David Whitney, technical staff assistant was very instrumental in helping with the lab studies. Nancy Zett did her usual excellent job in typing the manuscript.

David W. Fowler
Alvin H. Meyer
Mazen Jabri
Amr Tabbarah

ABSTRACT

This study evaluated the Chace Air Indicator (CAI) using sixteen concrete mix variables and has provided results conforming with the findings of previous research. The CAI indicated higher values than the pressure method at low air contents and lower values at high air contents. However, mortar-corrected CAI readings, using the proper Chace factor, gave values typically 15 percent higher than the pressure method over all ranges of air contents. A set of curve correction equations with confidence intervals indicating the reliability of results was suggested to adjust for deviations with results based on the average of one, two or three readings per test sample.

It is concluded that the performance of the CAI improves with increased number of readings per test sample and proper training of operators.

It is recommended that the CAI be used with care in testing concretes with high range water reducer at high air contents because of the variation of readings with time.

SUMMARY

The Chace Air Indicator (CAI) has been widely used as an indicator of the air content of portland cement concrete. The objectives of this study were to determine the ability of the CAI to measure the amount of entrained air with sufficient accuracy for job control purposes, the identification of limits for the use of the CAI and the determination of calibration requirements for the CAI. This report describes the laboratory phase of the study which included many variables such as temperature, slump, air content, cement type, aggregate type, and type of admixtures. The variability between operators and between instruments was also investigated.

It was found that the CAI indicated higher values of air than the pressure meter at low air contents and lower values at high contents. Correction curves were developed for the variables investigated. The correction has a 95 percent confidence interval of 3.2 percent air content for one CAI reading; for three readings the interval is reduced to 1.8 percent. The coefficient of variations for operations and instruments were less than five percent. Recommendations are made for improved usage of the CAI, including an accurate determination of the Chace factor, consistent operation of the CAI, and the use of a correction curve developed from the laboratory tests.

IMPLEMENTATION

This study had the primary objective of determining if the Chace Air Indicator can be used with sufficient accuracy for job control purposes. The laboratory study, reported herein, indicates that with proper care good accuracy can be achieved. The field measurement phase will provide the final answer to the question. The results of this study will be of significant benefit to the Department, especially if it is found that the CAI can be used for job control purposes.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Scope

This investigation is concerned with the evaluation of the Chace Air Indicator (CAI) and its validity in determining the amount of entrained air in structural concrete. The existing procedure for using the CAI specifies that it be correlated daily with the pressure method for job control purposes (5). Experience of some field personnel with the CAI had led them to question the necessity for daily correlation and to favor the removal of such a requirement to save manpower and testing time. However, before modifications can be adopted, additional information is needed to prove whether or not the performance for the CAI can adequately measure air content of the mix within the tolerances of the required standards.

1.2 Background

The CAI has been in use for about 25 years. Studies conducted by the Virginia Council of Highway Investigation and Research (2) and the Virginia Highway and Transportation Research Council (3) involving the AE-55 Indicator yielded the following conclusions and recommndations:

(1) The CAI can be used to provide a reasonably accurate indication of the air content of fresh concrete, provided results are based on the average of a minimum of two readings.

(2) Under field conditions, the CAI requires about one-fourth to one-third the time required by a pressure meter. The fragility of the instrument is offset by its low cost and ease of handling.

(3) The CAI should be used on concretes that lend themselves to the extraction of representative samples. Unscreened samples were found to yield better results.

(4) Each CAI should be inscribed with a Chace factor, which is defined as the volume of one graduation on the stem expressed as a percentage of the volume of the bowl. This factor is the basis of the mortar and curve corrections applied to the stem reading to take care of the fact that CAI reads low at high air contents.

1.3 Research Objectives

The objectives of this study were as follows:

(1) Determine if the CAI can measure the amount of entrained air with sufficient accuracy for job control purposes.

(2) Identify the limits or tolerances for the use of the CAI for either job control or as an indicator as it is presently used.

(3) Determine the calibration requirements for the CAI and the frequency of correlation with the pressure meter.

The study established guidelines for effective and reliable use of the CAI under several design and environmental variables, such as:

(1) Range of slump
(2) Range of air content
(3) Range of temperature
(4) Type of aggregates
(5) Type of cement
(6) Type of admixture

The results also provided information on the variability between test units and between operators and were used to determine correction curves for all variables.

CHAPTER 2

PREVIOUS RESEARCH

2.1 The Virginia Council of Highway Investigation and Research Study

This study (2) involved results of a statewide experiment to compare the CAI to conventional pressure methods. A total of 835 comparative field tests with various materials and operators were conducted. It was emphasized that the method was not intended to replace existing laboratory methods of air measurement but rather to be an aid in field control.

To take into account the fact that only mortar is used in the AE-55 Indicator test, instead of concrete, as used in the pressure method, a mortar correction based on the mix mortar content was adopted. A curve correction was also developed to correct for extreme deviations since it was found that the CAI read high at low air contents and low at high air contents.

It appeared also that uncorrected data gave a better measure of air content than data for which correction was attempted. This does not imply that such corrections were unnecessary, since their effect was beneficial in medium air ranges, but it suggests that additional testing should be performed and modifications should be applied to concrete with high or low values of air content.

Major conclusions from the study were:

(1) The AE-55 Indicator is a reasonably accurate and moderately precise device for field measurement of air content in concrete.

(2) Multiple readings are advisable for improved performance.

(3) Unscreened samples are suitable: it was found that 70 percent of the readings fall within one-half percentage point and 95 percent within one percentage point of air as determined by the pressure method.

2.2 The Virginia Highway and Transportation Research Council Study

The results of this study (3) concluded that poor agreement existed between the pressure method and the CAI. The pressure method gave values typically 30 percent higher than the CAI at high air contents. The error was due to the fact that the existing recommended mortar correction did not take into account the Chace factor of the CAI. The new recommended mortar correction was adopted by AASHTO (6). This correction can be represented in the form of the following equation:

$$\text{mortar correction factor} = \frac{\text{mortar content } (ft^3/yd^3) \times \text{Chace factor}}{27(ft^3/yd^3)}$$

The recommendations of the study specified that

(1) Each CAI should be inscribed with its Chace factor.

(2) CAI results should be based on stem readings that have been corrected using a Chace conversion nomograph (Fig. 2.1)

(3) CAI readings should be taken as the average of a minimum of two samples.

(4) Concrete investigated should be suitable for retrieving representative samples.

As a result of the Virginia study, the AASHTO Standard Method of Test for Air Content of Freshly Mixed Concrete by the Chace Indicator (TI99-82) (5) was modified to include the recommended corrections.

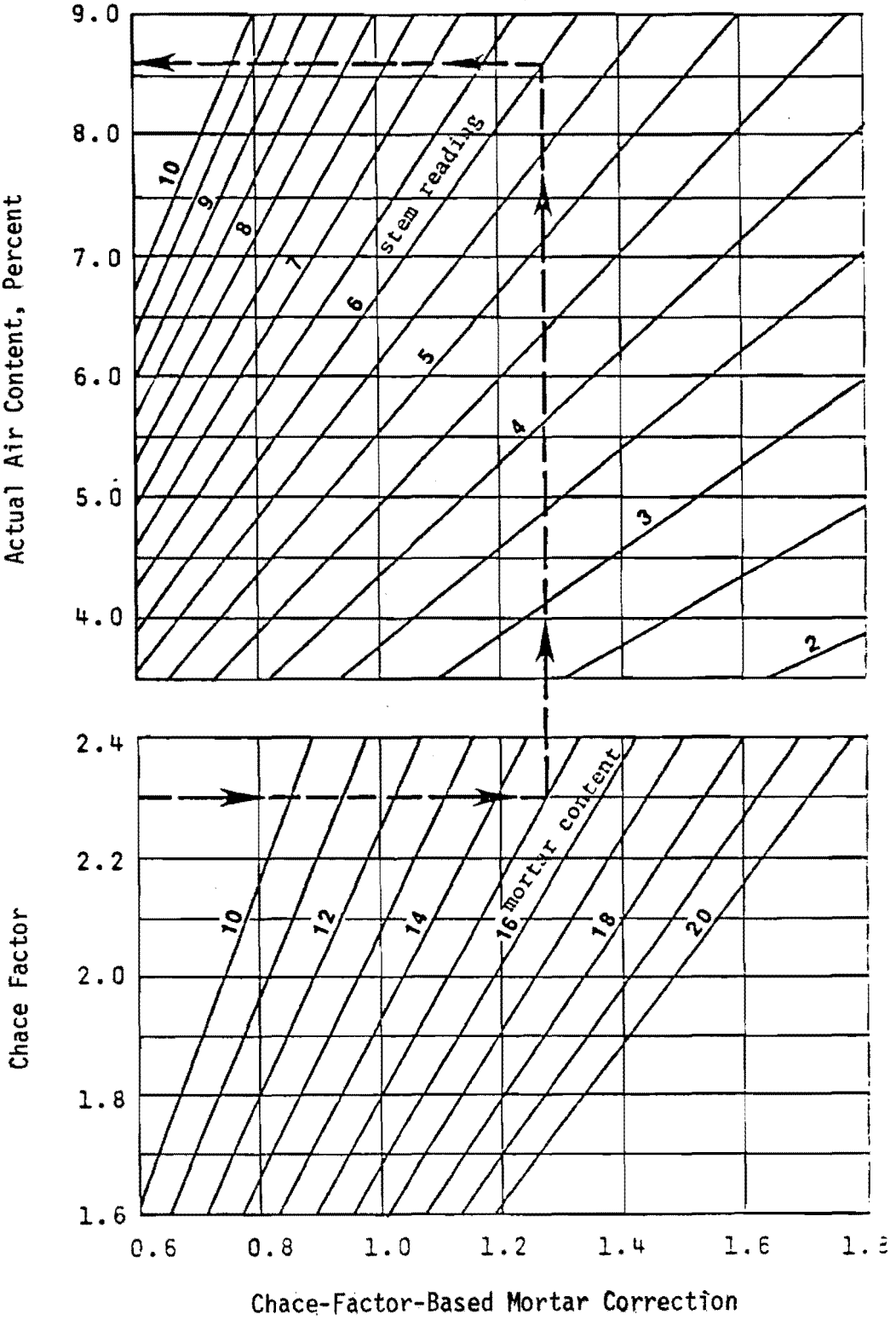

Fig. 2.1 Chace Conversion Nomograph (3).

2.3 The Materials and Tests Division at the Texas Highway Department Study

This study (1) found that the strength and temperature of alcohol used in the CAI test had a significant effect on results. It was recommended that

(1) Only 70 percent isopropyl alcohol diluted with water should be used.

(2) Temperature differentials should be avoided.

(3) The tests should be performed with care and as rapidly as possible.

CHAPTER 3

EXPERIMENTAL STUDY

3.1 Test Program

The test program included the mixing of two to three batches of concrete per day, along with the scheduled CAI and pressure meter tests. The batching operation was performed at two-hour intervals and the necessary materials were prepared and weighed in several buckets. The mixing operation took from two to three minutes after the last quantity of water and air entraining agent was added, and the fresh concrete was then poured in a wheelbarrow, ready for testing. At first a slump test was performed and a strength cylinder was filled. Then the testing proceeded with one operator using the three pressure meters and the other using the three CAIs, except for the first ten batches, where each of the three CAIs was used twice by each of the operators and each pressure meter was used only once by either operator.

3.2 Standard Design

A standard batch design was developed with specific characteristics. The variable under consideration was the item in subsequent mix designs that differed from the standard mix design. The test investigated the effect of the variable on the performance of the CAI relative to the pressure meter.

The Standard Design Characteristics (SDC) were

(1) type I portland cement,

(2) siliceous coarse (gravel) and fine (sand) aggregates,

(3) medium slump (3 to 5 in.),

(4) medium air content (6±1 percent),

(5) room temperature (75°F), and

(6) no admixture.

The only case where two properties varied at the same time was when a high range water reducer was involved. The immediate result of such an admixture was the increase of the slump range to high slump (5 to 8 in). Also, the effect of admixtures was tested for high (10±1 percent) and low (3±1 percent) air contents, and the effect of temperature was tested for high air contents with high slump.

3.3 List of Test Variables

Every variable was tested in five batches of 2 cubic feet each. The variables under investigation were

(1) low slump: used standard design characteristics (SDC) but with low slump,

(2) medium slump: used SDC,

(3) high slump used SCE with high slump,

(4) low air content: used SCD with low air content,

(5) high air content: used SCD with high air content,

(6) low temperature: used SCD with low temperature, high air content, and high slump,

(7) high temperature: used SDC with high temperature, high air content, and high slump,

(8) cement type II (CII): used standard design characteristics (SDC) but with type II cement,

(9) cement type III (CIII): had the same batch properties as with cement type II but with cement type III,

(10) water reducer at low air (WRLA): used SDC with the addition of a water reducing admixture at low air content,

(11) water reducer at high air (WRHA): had the same batch properties as with WRLA except that air design was in the high air range,

(12) high range water reducer at low air (HRWRLA): used SDC with the addition of a super plasticizer at low air content,

(13) high range water reducer at high air (HRWRHA): had the same batch properties as the HRWRLA except at high air content,

(14) siliceous coarse aggregate with limestone fine blends (SCLF): used SDC with limestone fines instead of sand,

(15) limestone coarse aggregate with siliceous fines (LCSF): used SDC with a crushed limestone coarse aggregate instead of gravel,

(16) limestone coarse aggregate with limestone fine blends (LCLF): used SDC with both coarse and fine limestone aggregates instead of gravel and sand.

Table A1 illustrates the interaction between the variables and summarizes in a simple manner the properties of the concrete designed for each variable. Appendix A contains all data sheets for each of these variables.

All of the cement used in these tests was purchased from the same mill lot to minimize variability in its chemical composition. All other materials were similarly secured from single lots.

3.4 Data Sheet Information

The following information was recorded for each batch:

(1) ambient temperature and humidity,

(2) properties and quantities of mix materials,

(3) design and measured air content and slump,

(4) 28-day design compressure strength and actual strength. Strength tests were performed on three cylinders out of five batches for every variable. Mix design and strength requirements conformed to specifications by the State Department of Highways and Public Transportation (SDHPT)(7) for class C concrete.

(5) 9 CAI readings and 3 pressure meter readings. In each case, 3 CAIs and 3 pressure meters were used.

(6) the names of operators who performed the test. For the first 10 batches, operators alternated in performing repeated tests on the CAI and the pressure meter to help determine instrument and operator variabilities.

Additional information on materials properties is provided in Appendix B.

CHAPTER 4

TEST APPARATUS AND PROCEDURE

4.1 CAI Apparatus

The ACI apparatus is composed of five items (Figs. 4.1 and 4.2):

(1) an indicator consisting of two pieces, a glass tube and a rubber stopper. The glass tube is about 3-in. long and 1 in. in diameter with a stem 3-in. long and 1/4 in. in diameter. The stem of the glass tube is scribed with eleven marks, each pair indicating a volume of 0.08 ml. A reference mark is also scribed on the large portion of the tube. The rubber stopper is mounted with a brass cup on its smaller end to fit the larger end of the glass tube. The brass cup has a 3/4-in. inside diameter, is 1/2-in. in depth and, has a volume of 1/2 ml. When the stopper and cup are inserted into the glass tube, the total volume is about 27 ml.

(2) a medicine dropper having a tip small enough to enter the graduated stem of the indicator,

(3) a quantity of 70 percent isopropyl alcohol,

(4) a thin, stiff metal wire or a No. 1 Gem paper clip to act as a rodding device to the mortar in the cup, and

(5) a spatula or a narrow blade knife to pick up the mortar.

4.2 Test Procedure

The procedure is presented as outlined in SDHPT Test Method Tex416-A (5) and it comprises the following steps:

(1) fill the brass cup with cement mortar from the concrete to be tested, excluding particles of sand which would be retained on a number 10 sieve. A narrow knife blade is most suitable to pick up

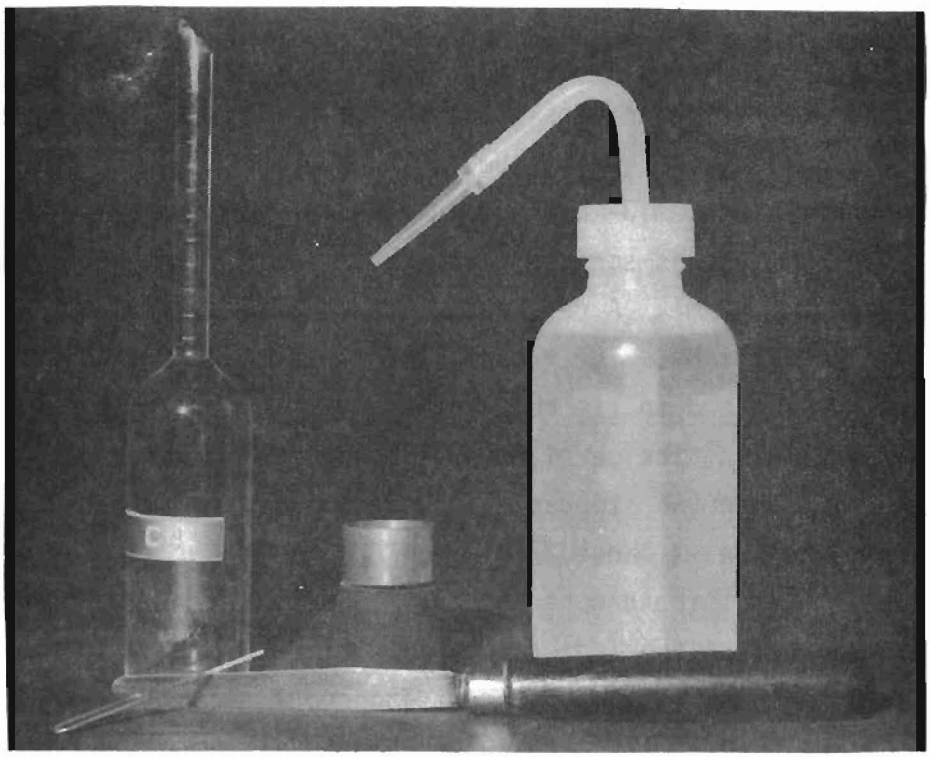

Fig. 4.1 CAI Apparatus: Indicator, Spatula, Alcohol Bottle, Stiff Wire

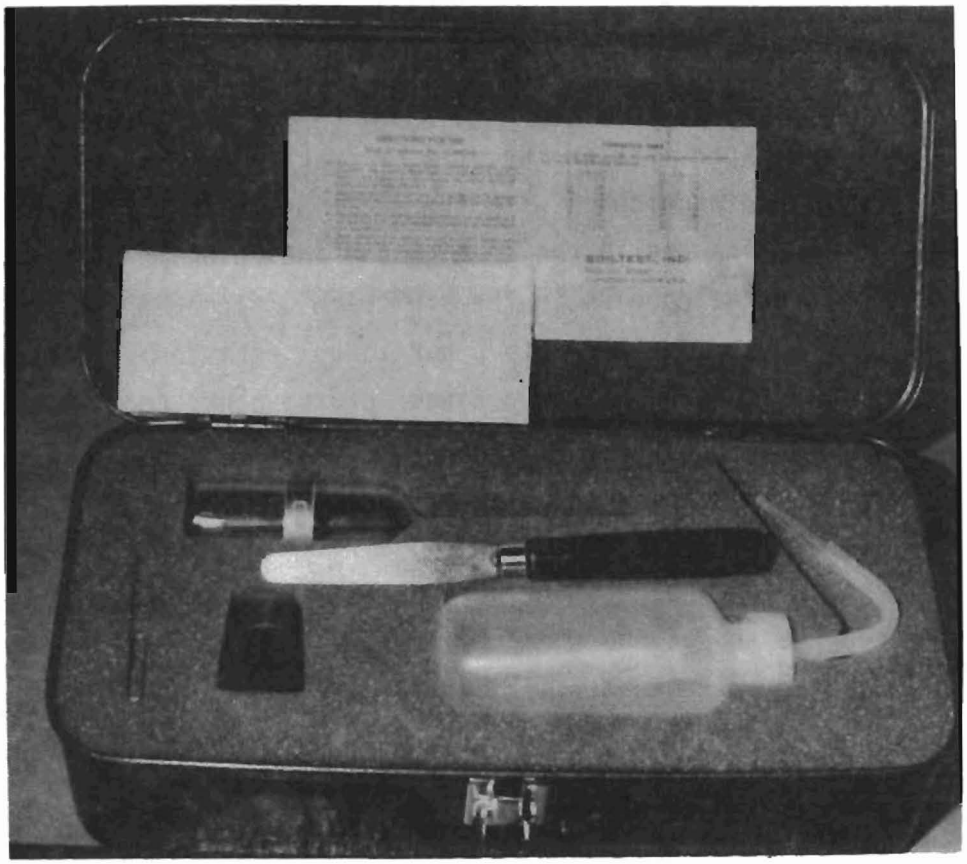

Fig. 4.2 CAI Apparatus in the Field Kit

the mortar. Rod the mortar in the cup using a thin stiff wire and strike off the mortar flush with the top of the cup. Clean the sides of the cup and stopper of mortar.

(2) Close the smaller end of the indicator with a finger and fill the tube with alcohol to the reference line. Insert the stopper into the tube, invert the indicator, and bring the level of the alcohol to the upper mark on the stem by pushing the stopper in farther or by adding alcohol with the medicine dropper. Be certain that no air bubbles are in the stem of the indicator.

(3) Close the opening in the stem with a finger and gently roll the indicator from a vertical to a horizontal position while tapping the side of the indicator with a finger of the other hand. Care shall be taken not to change the setting of the stopper. Continue the rolling and tapping until all of the mortar is dispersed in the alcohol and no more bubbles of air appear.

(4) With the indicator held in a vertical position, remove the finger from the end of the stem and read the level of the alcohol in the stem to the nearest half graduation.

4.3 Recommended Modifications

Some modifications to the existing procedure are recommended to improve the performance of the CAI. Such adjustments were found to be effective as the laboratory phase progressed and operators became more familiar with the CAI. The suggested modifications were:

(1) Start with clean and dry indicator, stopper and cup.

(2) Rod the mortar uniformly about 20 times (Fig (4.2'). If large sand particles are detected during rodding, they should be removed.

(3) After rodding the mortar, gently tap the sides of the cup with the handle of the spatula to eliminate irregularities and fill possible air pockets with mortar (Fig. 4.3).

(4) When striking the mortar flush with the cup, apply a gentle saw motion with the blade of the spatula on the top of the cup to insure a smooth, level surface.

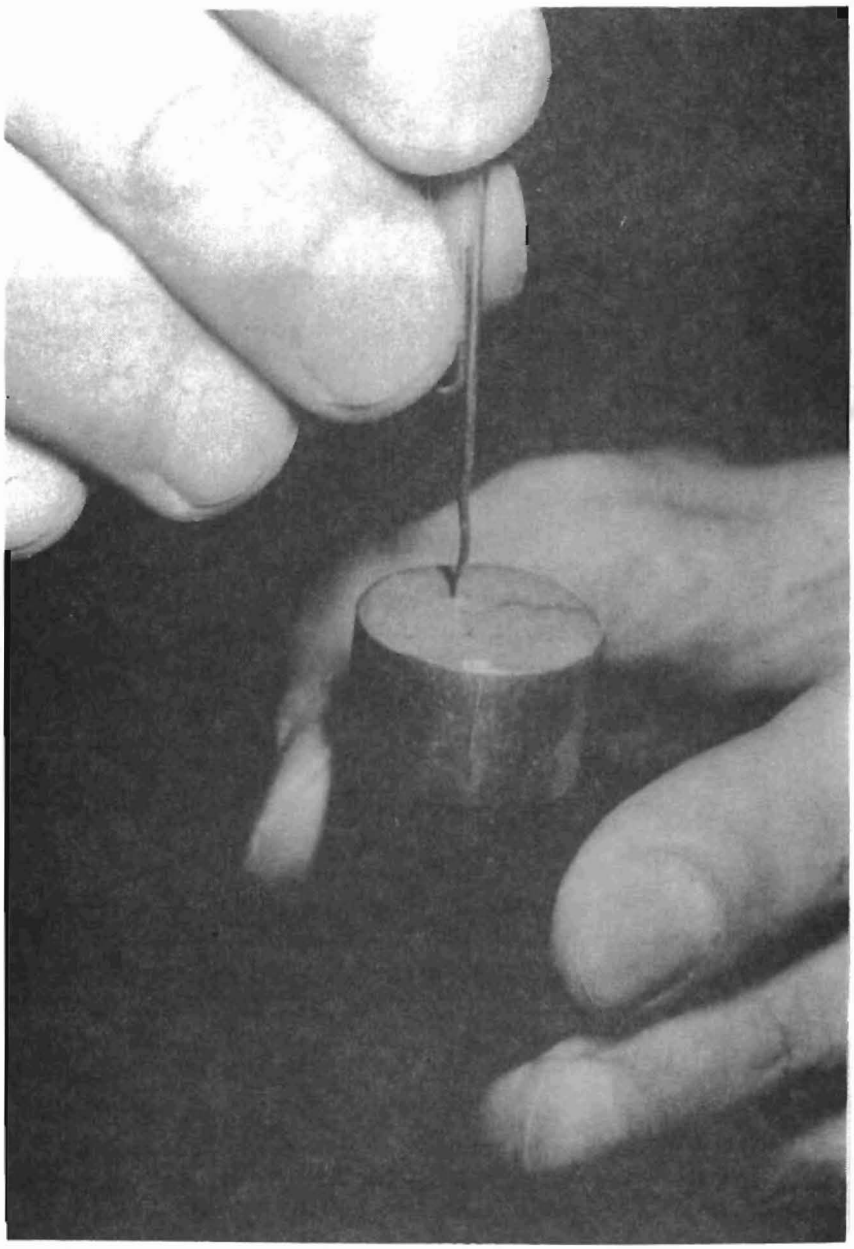

Fig. 4.2' Rodding the Mortar with a Thin Stiff Wire

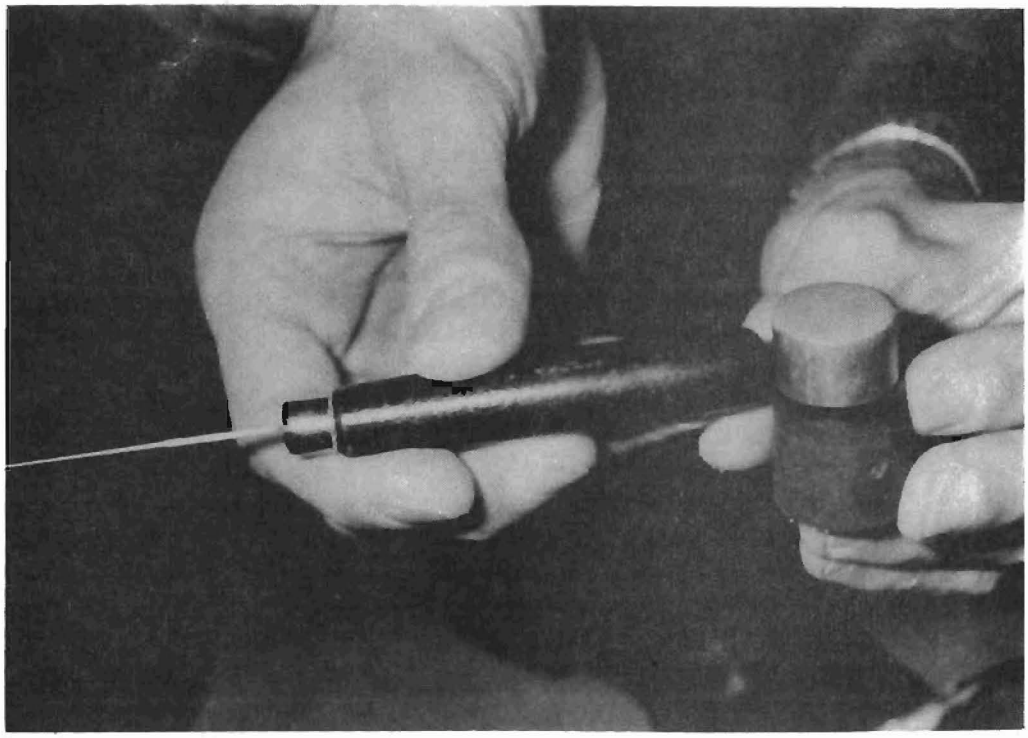

Fig. 4.3 Tapping Action on the Sides of the Cup

(5) Clean the sides of the bowl with tissue and not with the finger (Fig. 4.4).

(6) Before filling the tube with alcohol, invert the indicator, close the smaller end of the indicator with the forefinger, and hold the stem between the thumb and the middle finger (Fig. 4.5). Holding the tube in this manner reduces the chance of the tube's slipping between the fingers.

(7) After inserting the stopper into the tube and inverting the indicator, push the stopper farther into the tube irrespective of the level of alcohol inside the stem (Fig. 4.6). This will prevent the possible movement of the stopper during the test and prevent premature change in alcohol level from the original zero setting.

(8) Put the indicator on a level surface and bring the level of the alcohol to the upper mark of the stem either by adding more alcohol with the medicine dropper or by removing the excess alcohol with twisted paper towel corner (Fig. 4.7). The level of the alcohol is adequate if the bottom of the meniscus coincides with the upper mark of the stem.

(9) Before rolling the indicator, wet the forefinger that will close the opening of the stem with water (Fig. 4.8). This will provide better alcohol-tight contact surface between the finger and the glass tube, thus reducing possible alcohol loss during the test.

(10) The indicator should be held with both hands. The forefinger and thumb of one hand are used to close the open end of the stem, while the same fingers of the other hand are used to hold the tube from the large end over the portion covering the brass cup.

(11) Before starting the rolling and tapping motion, shake the CAI in a gentle lateral vibratory motion to drop the lump of mortar into the alcohol. This action will insure the complete emptying of the cup (Fig. 4.9).

(12) While rolling the indicator from the vertical to the horizontal position, continue the lateral shaking. To determine that all the mortar is dispersed, stop the rolling and hold the indicator vertically without

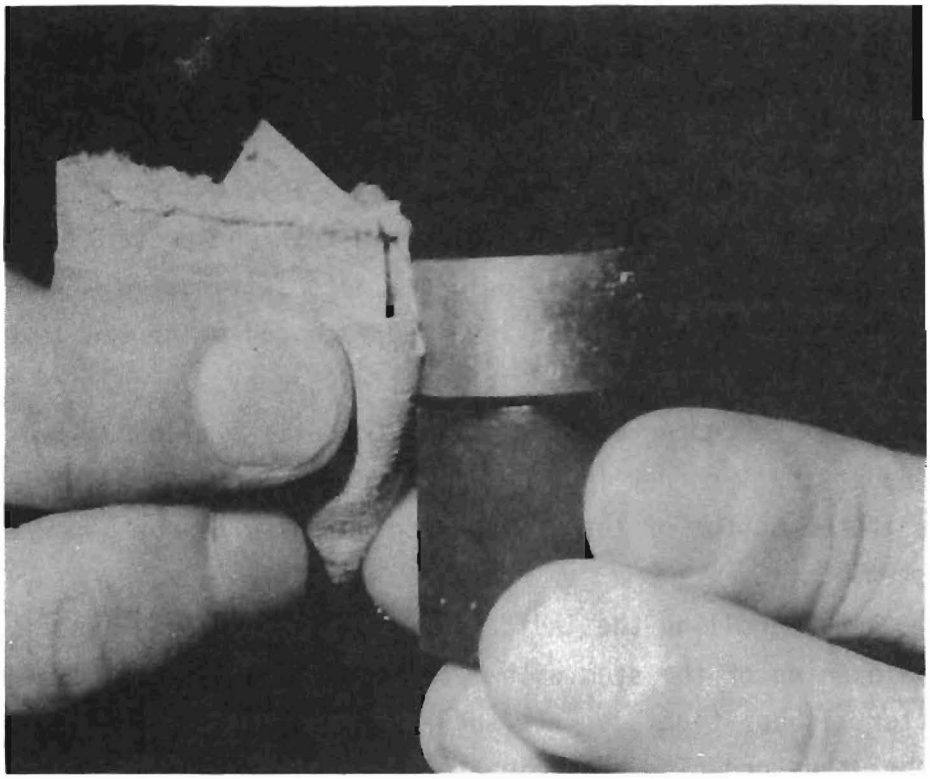

Fig. 4.4 Cleaning the Sides of the Cup

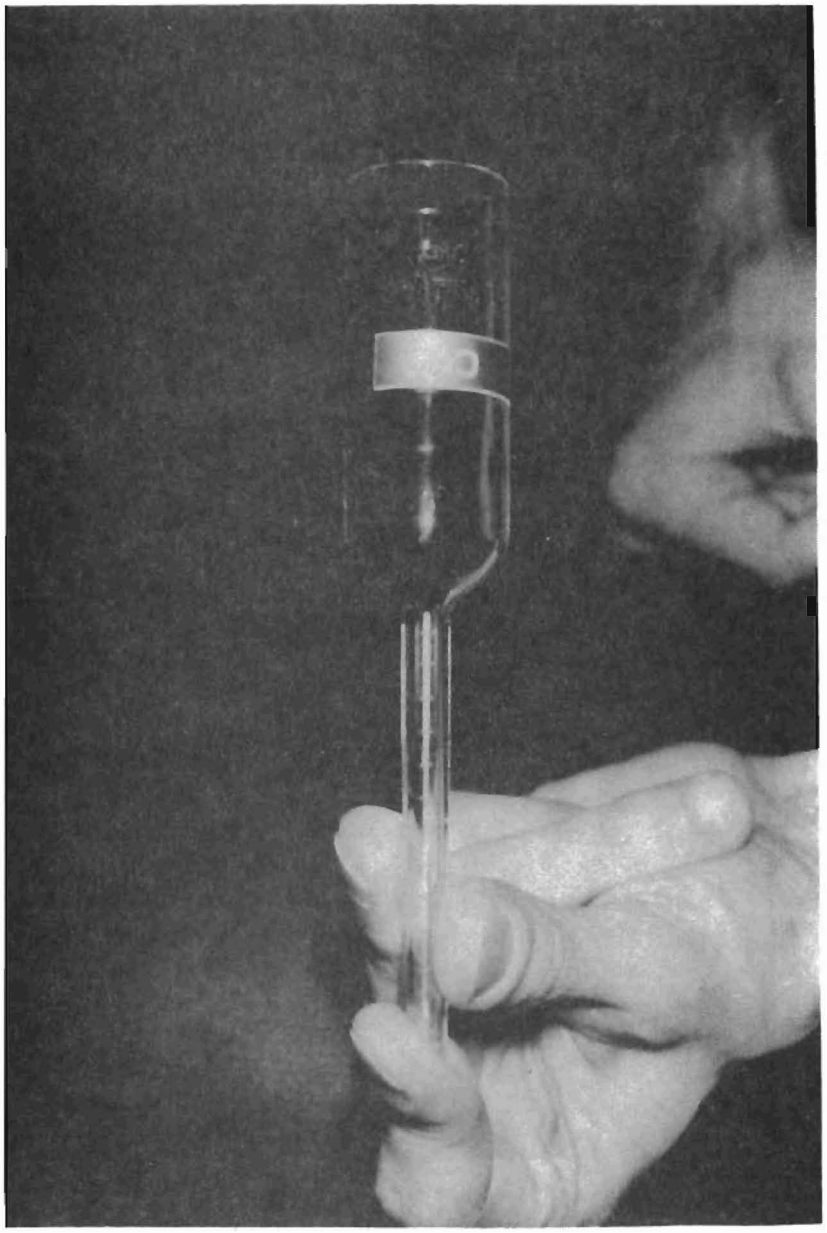

Fig. 4.5 Holding the Tube

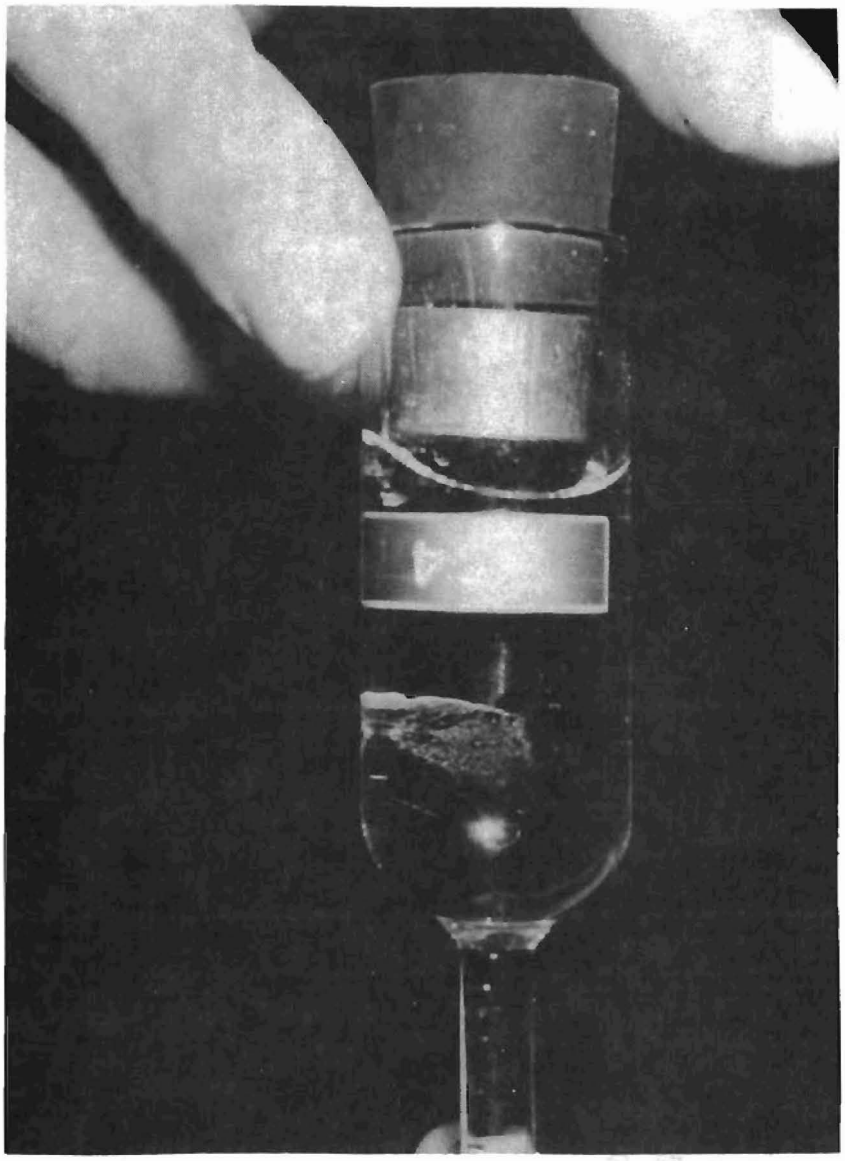

Fig. 4.6 Inserting the Stopper into the Tube

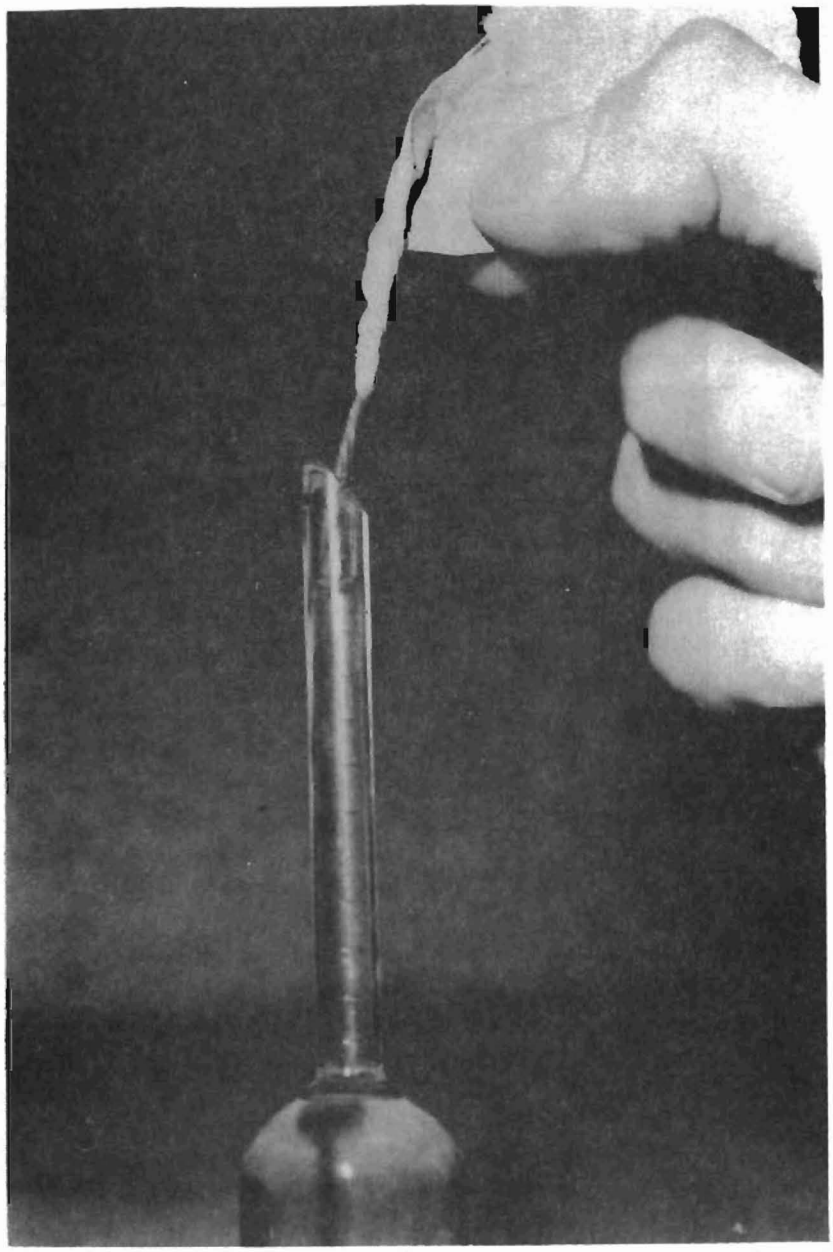

Fig. 4.7 Removing the Excess Alcohol

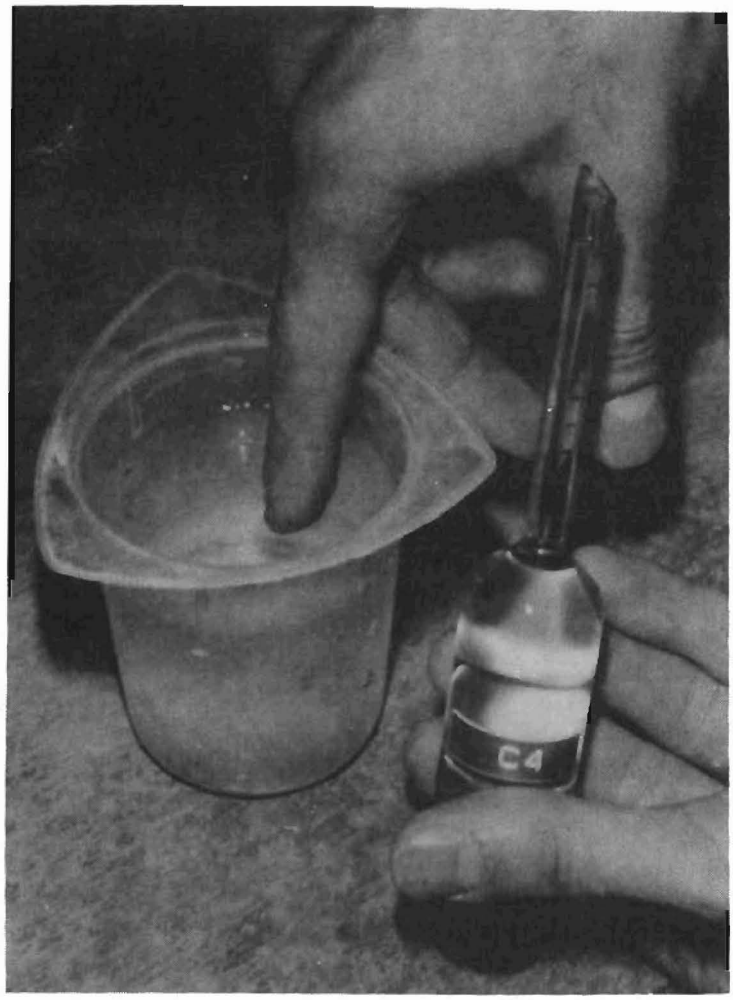

Fig. 4.8 Wetting the Forefinger

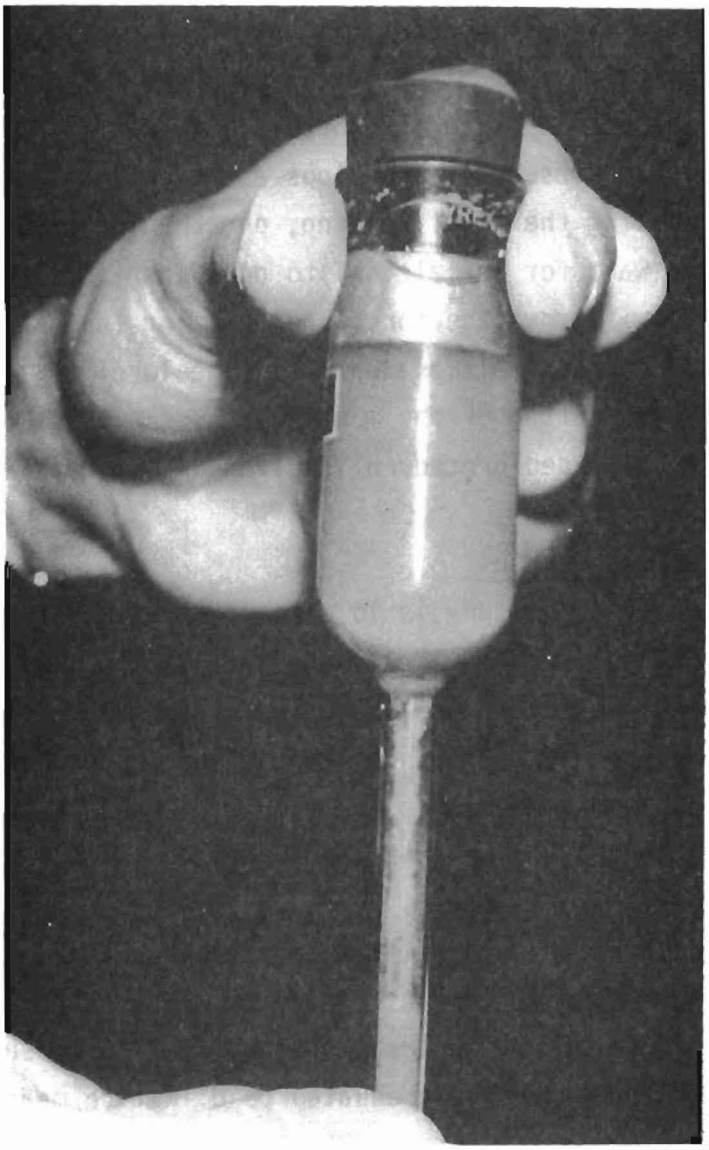

Fig. 4.9 Emptying the Cup

removing the forefinger from the stem opening, wait for the alcohol to drop down and for the large air bubbles to go up, and take an approximate reading. Repeat the rolling and shaking several times and take a new approximate reading; if the two readings are similar then all the mortar is dispersed, if not, repeat the rolling, shaking, and reading until two consecutive readings are identical.

(13) Before taking the final reading, put the indicator on a level surface, and wait for the alcohol to drop down and for the large air bubbles to rise. Remove the forefinger closing the stem and take the reading to the nearest half graduation. The level of the alcohol is represented by the bottom of the meniscus (Fig. 4.10).

A complete recommended procedure is given in Appendix G.

4.4 Suggested Field Apparatus

The objective of this study is to simplify the task for the field personnel without jeopardizing the quality of testing. By providing additional equipment that is easy to use and carry, performance can be improved. In addition to the standard equipment (Fig. 4.2), it is advisable for the inspector to carry a plastic bottle (Fig. 4.11) to rinse the CAI and wet his finger.

In case the Chace factor needs to be determined in the field, the apparatus sufficient to perform the operation can be composed of 70 percent isopropyl alcohol used as liquid to measure the volumes of the stem and cup, a pipette graduated to 0.01 ml to measure the volume of the stem and a pipette graduated to 0.1 ml to measure the volume of the cup.

The volume can be read directly from the change in alcohol level in the pipette upon filling the respective elements.

4.5 Tapping/Tapping and Shaking

Additional laboratory testing was performed to determine the difference, if any, between readings from the CAI when tapped, or tapped and shaken during the emptying of the cup of mortar and rolling. Eight batches were tested and their data sheets are included

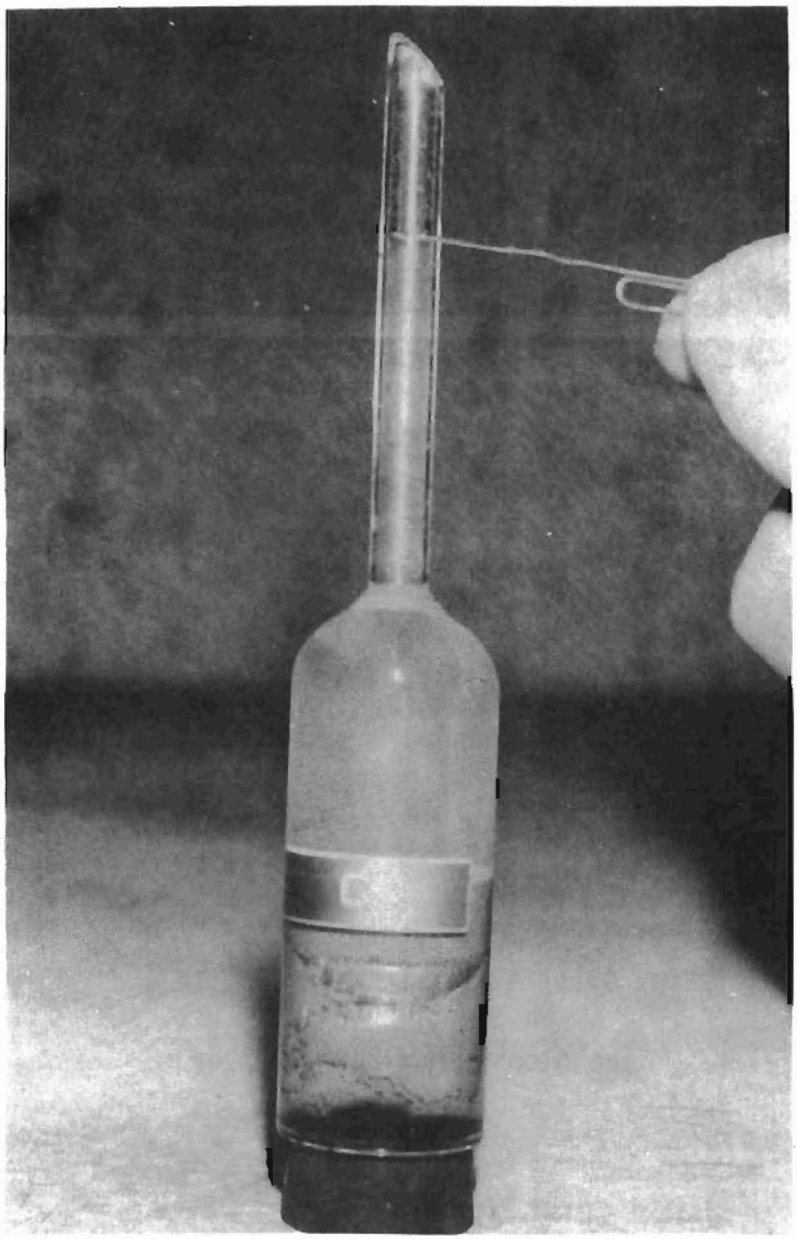

Fig. 4.10 Taking the Reading

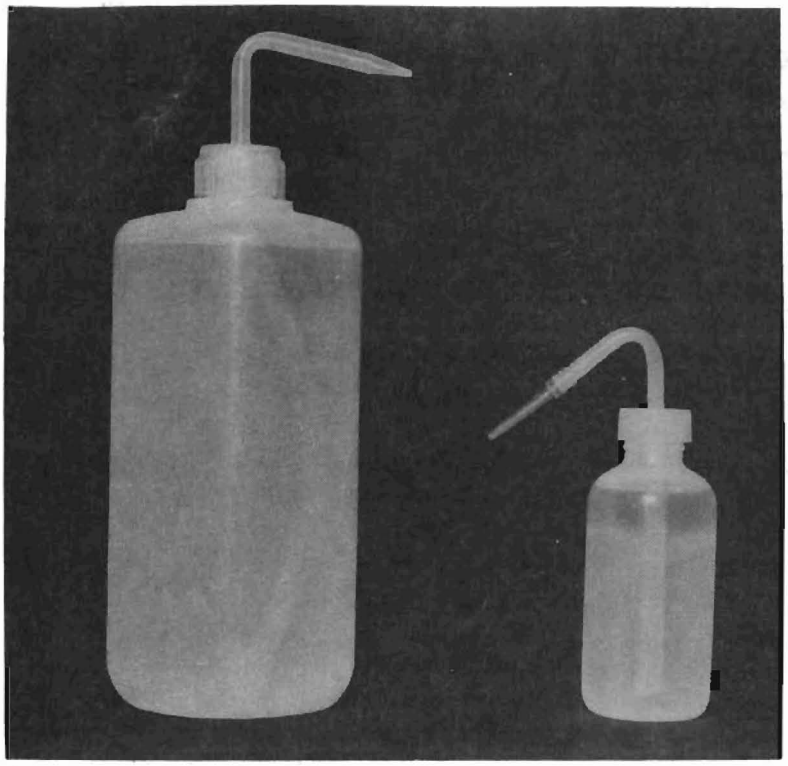

Fig. 4.11 A Plastic Water Bottle and

an Alcohol Medicine Dropper

in Appendix H. Only one CAI was used with each batch. Six CAI readings were taken, three with taping and three with tapping and shaking. The average ($\bar{x}$) and the percent coefficient of variation (cv, percent) for each batch are shown in Table 4.1.

Table 4.1 Shaking and Tapping

		CAI Air Content (percent)							
		Low			Medium			High	
Tapping and Shaking Method	$\bar{x}$*	3.8	4.3	3.7	6.0	5.8	5.8	8.5	9.0
	cv**	7.5	6.7	7.9	8.3	4.9	4.9	5.9	5.6
Tapping Method	$\bar{x}$*	3.7	4.2	3.7	5.0	5.5	5.5	7.8	8.0
	cv**	7.9	6.9	7.9	0.0	0.0	0.0	3.7	6.2

* Mean
** coefficient of variation

The testing time for the tapping method was between two and three minutes longer than the tapping and shaking method. The average readings are higher for the tapping and shaking method, which indicates that the mortar is more dispersed than with the tapping method. All the coefficient of variation are within the acceptable range, 10%.

CHAPTER 5

DATA ANALYSIS

5.1 Scope

In this chapter, the methods of data analysis are outlined. Analytical and graphical results of the data analysis are presented in Chapter 6. The statistical analysis began with organizing the data into three classes confoming to the type of analysis considered. The classes of analysis were

(1) a regression analysis of the mortar-corrected readings for all instruments,

(2) an analysis of instrument variability, and

(3) an analysis of operator variability.

5.2 Pre-Analysis Calculations

5.2.1 Actual Mortar Content (MC)

The actual mortar content for each batch of concrete was found. When the designed air content and the actual air content are the same the actual mortar content is given by

MC = 27 - (Absolute volume of coarse aggregate in one cu yd of concrete, expressed in cu ft) (5.1)

If the actual air content is not the same as the design air content, the total volume of the concrete changes. The equation for the actual mortar content is derived in Appendix F and is given by

$$MC = 27 - \frac{(27)(CAF)(UW)(1 - p)}{(62.4)(G)(1 - P)} \quad (5.2)$$

where MC = actual mortar content in the concrete in cu ft/cu yd and is defined as the total volume of the concrete (27 cu ft) minus the absulute volume of the coarse aggregates, expressed in cu ft,

CAF = coarse aggregate factor,

UW = saturated surface dry unit weight of the coarse aggregate in use, expressed in lb/cu ft,

G = saturated surface dry specific gravity of the coarse aggregates in use,

P = designed air content, expressed as a decimal fraction,

p = actual air content as represented by the average of the pressure meter readings, expressed as a decimal fraction.

5.2.2 Mortar Correction Factor

The Mortar Correction Factor (MCF) is the number by which the reading or average of readings of the CAI should be multiplied to obtain the theoretically correct air content in the concrete. The MCF is given by

$$MCF = \frac{(CF)(MC)}{27} \tag{5.3}$$

where CF = Chace Factor of the CAI used,

MC = actual mortar content in the concrete, defined by equation 5.2 and expressed in cu ft/cu yd.

Equation 5.3 is represented by the lower part of the Chace Conversion Nomograph (Fig. 2.1).

5.2.3 Uncorrected and Mortar Corrected Readings

The mortar corrected reading or average of readings (Xmc) is given by

$Xmc = (MCF(Xu)$

where

Xu = uncorrected reading or average of readings as read from the CAI.

For every batch of concrete three readings were taken with each of the three CAIs and three sets of calculations were made whereby

(1) Xu represents the first uncorrected reading for each CAI,

(2) Xu represents the average of the first two uncorrected readings for each CAI, and

(3) Xu represents the average of the three uncorrected readings for each CAI,

and the corresponding Xmc was found.

5.3 Instrument Variability

Both types of instuments, the CAI and the pressure meter, were tested for variability.

5.3.1 CAI Variability

CAI variability accounts for differences between instruments. A random sample of six batches was selected. Averages of readings performed by the same operator on several instruments were collected. The coefficient of variation (cv) between instruments was calculated as follows:

$$cv = \frac{s}{\overline{X}}$$ where $\overline{X}$ is the mean of means and $s = \frac{\sigma}{\sqrt{n}}$ where

σ is the standard deviation of average CAI readings and n is the number of readings in a single sample (1, 2, or 3). An average cv for the six batches was adopted as being the coefficient of variation between Chace Air Indicators.

5.3.2 Pressure Meter Variability

Two kinds of pressure meter variability were computed: the variability between instruments and the variability within the same

instrument (for multiple readings). The same approach outlined in the previous section was used on a sample of six batches.

5.4 Operator Variability

Operator variability accounts for the difference in performance between operators. Readings performed on the same instrument by different operators were collected and an analysis similar to that used to determine instrumental variability was made. This variability index also defines the variability of each CAI.

Note that the confidence interval is expressed as a percent of air while instrument and operator variabilities are expressed as a percent of relative error with respect to the average reading.

5.5 Regression Analysis

To perform the linear regression analysis all the data obtained from the laboratory phase were needed, used except that the data obtained from the variable "High Range Water Reducer at High Air Content" (HRWRHA) were excluded since the readings on both the PMs and the CAIs were decreasing with time, and the comparision of these readings was not possible.

5.5.1 Purpose

Linear regression allows the analysis of the relationship of one variable to another. The objective is to perform a least-squares linear regression which is designed to minimize the sum of the squares of the deviations of the actual data points from the straight lines of best fit. The data points used are represented by two coordinates. The abscissa is the mortar-corrected CAI reading or average of readings and the ordinate is the average of the PM readings.

The desired result is a linear equation that best fits the data points and could be used to project the actual air content through the knowledge of a mortar corrected CAI reading.

5.5.2 Technique

Each batch had a number of averages of mortar-corrected CAI readings and one average of PM readings. Each set of two numbers, the first being a mortar-corrected CAI reading or average of readings (Xmc) and the second being the average PM reading (PMR) for the same batch, represented one data point. Excluding the variable HRWRHA the total number of data points was 248.

The regression analysis was performed separately for three sets of data points (Xmc, PMR) where

(1) Xmc represents the first mortar corrected CAI reading,

(2) Xmc represents the mortar corrected average of the first two CAI readings, and

(3) Xmc represents the mortar corrected average of the three CAI readings.

The same technique was used for each of these three sets of data points.

5.5.2.1 First Equation

The linear regression was applied to the set of 248 points (Xmc, PMR) and the linear equation that best fits these points is expressed by:

$$Y1 = (a1)Xmc + b1 \qquad (5.5)$$

where a1 and b1 are constants and represent the slope and intercept of the straight line respectively.

Because the data are seldom perfectly linear, it was necessary to measure how well the line fitted to the data actually does approximate the data. This measure is called the correlation coefficient (R). The value of R ranges from -1 to +1. High positive and high negative values of R reflects that there is some linkage between the two variables it is correlating and that the value of one can be used to estimate the value of the other.

5.5.2.2 New Set of Points

To determine the accuracy of equation 5.5 in representing the set of points (Xmc, PMR), a new set of points (Xmc, Y1) was found, where Y1 was the ordinate of the new point and calculated from equation 5.5.

5.5.2.3 Difference

Each value of Xmc had a corresponding value for PMR and Y1. Their difference (PMR - Y1) represented the accuracy of equation 5.5, and constituted the number that should be added to Y1 to obtain the original ordinate PMR. Using each value of Y1 it was necessary to find its corresponding value (d) equivalent to (PMR - Y1) that would represent the PMR after being added to Y1. To determine the d values, a linear regression was performed on the set of points represented by (Y1, (PMR - Y1)). The linear equation that best fitted these points was expressed by

$$d = (a2)Y1 + b2 \qquad (5.6)$$

where a2 and b2 are constants and represent the slope and intercept of the straight line, respectively.

5.5.2.4 The New Equation

Theoretically, adding d to Y1 should give the PMR, but, since the data were not perfectly linear, it was necessary to determine the accuracy of (Y1 + d) in representing the PMR. A linear regression was performed on the set of points (Y1 + d, PMR) where d was found from equation 5.6. The linear equation that best fits these points was given by

$$Y = (A)(Y1 + d) + B \qquad (5.7)$$

where A and B are constants and represent the slope and intercept of the straight line, respectively.

If all the (Y1 + d) values were equal to the PMR values, A and B would be exactly 1.00 and 0.00 respectively and the corresponding correlation coefficient R would be exactly 1.00.

5.5.2.5 The Final Equation

Replacing d by its expression in equation 5.6 and Y1 by its expression in equation 5.5, equation 5.7 becomes

$$Y = [(A)(1 + a2)(a1)] (Xmc) + [(A)(1 + a2)(b1) + (A) (b2) + B] \quad (5.8)$$

Expressing equation 5.8 in simpler form,

$$Y = (S)(Xmc) + I \quad (5.9)$$

where

$$S = (A)(1 + a2)(a1) \quad (5.10)$$

and

$$I + (A)(1 + a2)(b1) + Ab2 + B \quad (5.11)$$

5.5.2.6 Confidence Interval

The 95 percent confidence interval is sought. It is denoted by 2k, where k is expressed as follows:

$$\frac{k = (1.97)(sigma)}{n} \quad (5.12)$$

where sigma = standard deviation derived from all (PMR - Y1) values,
n = number of readings represented by Xmc, and
k is expressed as percent air content.

Having obtained Xu from direct reading from the CAI, Xmc from equation 5.4, and Y from equation 5.8, there is a 95 percent probability that the value of actual air content is between the values (Y - k) and (Y + k).

The use of equation 5.12 assumes a normal distribution of the (PMR - Y1) values around their mean. This mean was assumed to be zero. The actual value of this mean was found to have a value very close to zero. The correlation coefficient for the set of points [(Y1, (PMR-Y1)] used to derive equation 5.6 was found to have a value which was very close to zero. This reflects the fact that Y1 and (PMR - Y1) were not correlated and that the points were distributed normally around their mean value.

The technique described in 5.5.2 required three regression analyses. The function of each is summarized below. The first regression analysis found the best fit straight line for the points (Xmc, PMR). The second regression analysis found the correlation coefficient for the set of points [(Y1, (PMR - Y1)], their best fit, and the mean and standard deviation of the (PMR - Y1) values. The d values obtained from equation 5.5, which is the result of the second regression analysis, were equal to 0.0 for all the 248 points. As a result, no additional correction was needed for the first regression analysis. The third regression analysis found how accurate the first regression analysis was, by determining the best fit straight line for the points [(Y1 + d), PMR)]. The first regression analysis was determined to be good since the third regression analysis obtained a best fit straight line that approximates very closely the line of equality. From all these analyses, it is seen that the first regression was accurate enough, but to obtain the confidence interval and to see how close the best fit approximates the line of equality, the second and third regression analyses were required. All that equation 5.7 provides is a general expression to adjust the first regression analysis in case non-zero values for d are obtained. Applying it to the data on hand changes a1 and b1 into S and I respectively. The slight change in values is due to the zero values for d.

CHAPTER 6

RESULTS OF ANALYSES

This chapter presents the graphical and analytical results of the data analysis. Preliminary analysis indicated that it was desirable to combine all data to get a more comprehensive correction curve. Attempts at individual correction curves for each variable were not successful because the number of points in each case was small and the result was a set of 16 equations, since 16 variables were investigated in the two studies. Instead, a single curve was adopted to include all points from all variables. However, the data of concrete with the high range water reducer at high air content were excluded from the regression analysis because it presented an additional variability, not accounted for in the test program. This variability was a decreasing trend of the air readings with time on both the CAI and the pressure meter.

6.1 Regression Analysis

6.1.1 Results Using Single CAI Readings

The value of the constants in equations 5.5, 5.6, 5.7, and 5.9, the corresponding correlation coefficients, and the values of the confidence interval are given below.

Taking only the first reading of the three available with each CAI and performing the regression analysis as described in Section 5.5 gave the following results:

In equation 5.5: $a_1 = 0.836$

$b_1 = 0.14$

$R = 0.946$

In equation 5.6: a2 = 0.00240
b2 = -0.0232
R = 0.0070

The near zero value of R shows that there is not any relavant pattern in the relation between Y1 and (PMR - Y1) and hence the assumption of normal distribution of the values of (PMR - Y1) around their mean is reasonable.

The mean value for (PMR - Y1) was found to be equal to -0.0081, the related sigma equal to 0.825, and the corresponding n equal to 1. Replacing sigma and n by their values in equation 5.12 yields

k = 1.6 percent and 2k = 3.2 percent.

In equation 5.7:

A = 1.00

B = -0.0232

R = 0.946

Replacing these values in Equations 5.10 and 5.11 yields

S = 0.840 and I = 0.068

and the final equation becomes

$$Y = (0.840)Xmc + 0.068 \qquad (6.1)$$

with the 95 percent confidence interval equal to 3.2 percent air content.

The points (Xmc, PMR) and their corresponding best fit straight line, equation 5.5 are illustrated by Fig. 6.1, where the 45 degree dashed line represents the line of equality.

It is seen that the mortar corrected readings give higher values of air content than the actual values represented by the PMR, hence the need to adjust these readings through the use of Equation 6.1. The A and B coefficients reflect how close the best fit of the points is to the 45 degree line of equality.

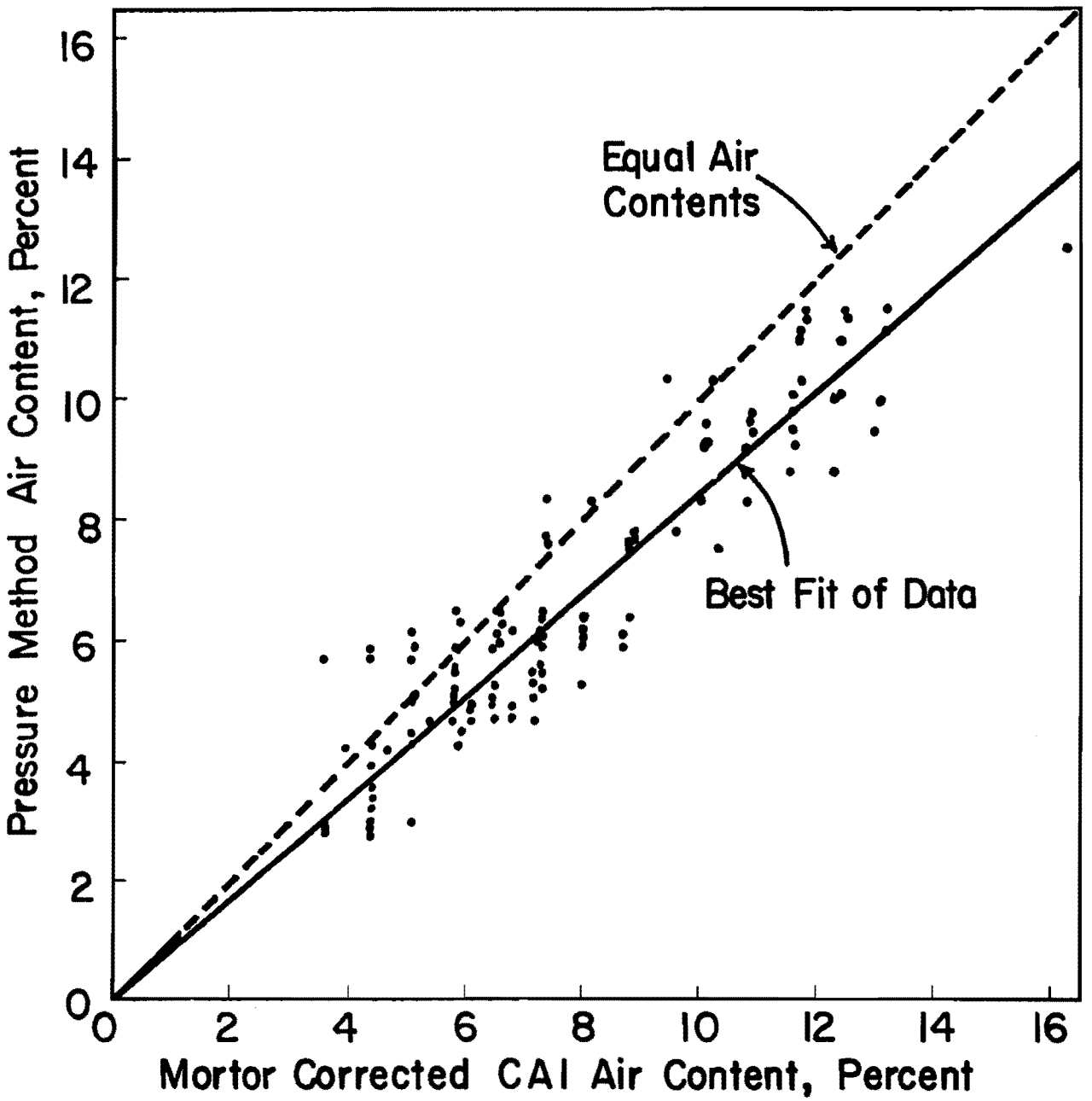

Fig. 6.1 Best Fit Straight Line and Scatter of Points for Mortar Corrected First CAI Readings

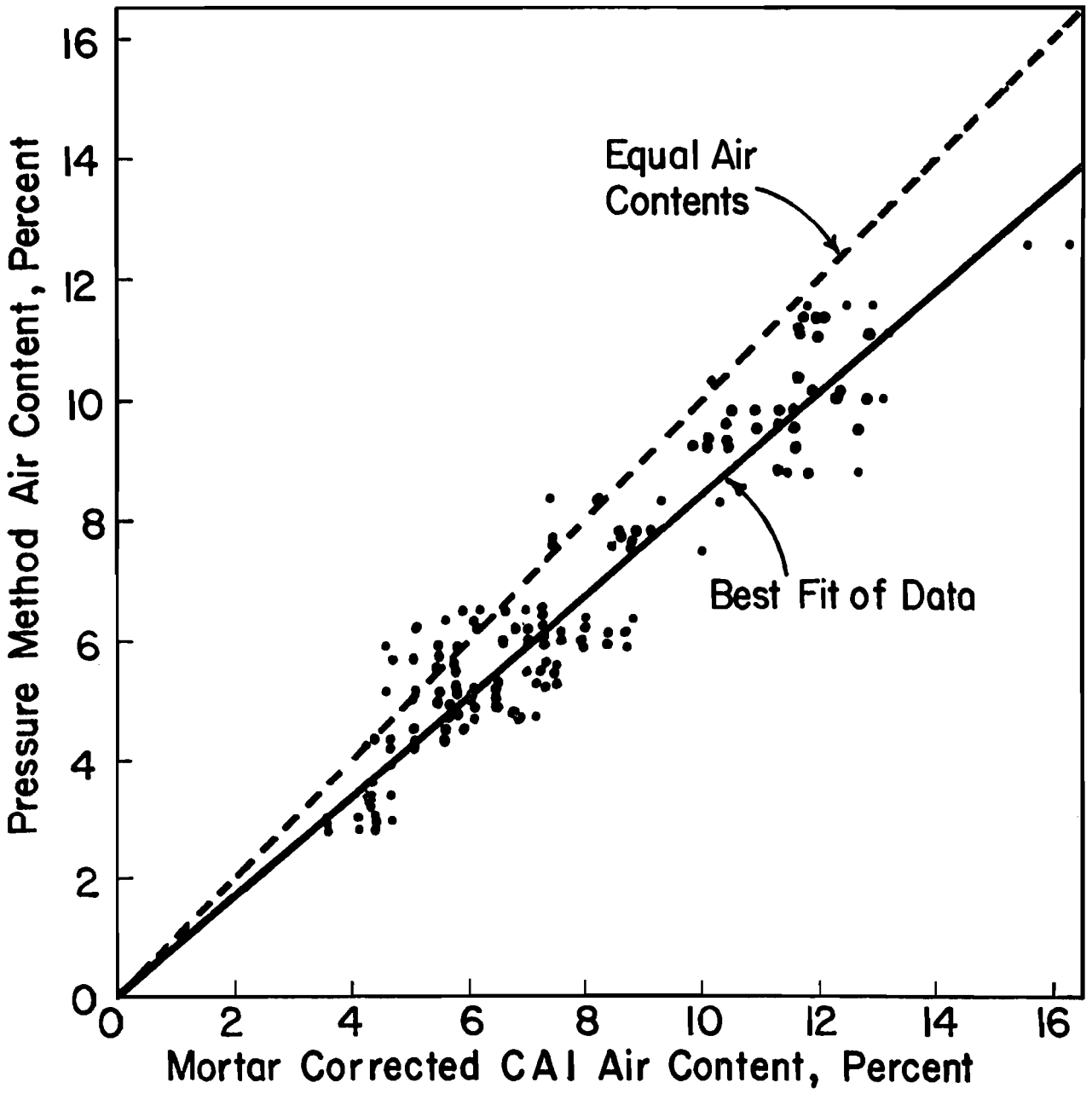

Fig. 6.2 Best Fit Straight Line and Scatter of Points for Mortar Corrected Average of First Two CAI Readings

6.1.2 Results Using Average of First Two CAI Readings

Taking the average of the first two readings out of the three available with each CAI and performing the regression analysis as described in Section 5.5 gives the following results.

In equation 5.5: a1 = 0.845
b1 = 0.0528
R = 0.949

In equation 5.6: a2 = -0.00703
b2 = 0.0436
R = -0.0197

The mean value for (PMR - Y1) was found to be equal to -0.0040, the related sigma equal to 0.859, and the corresponding n equal to 2. Replacing sigma and n by their values in equation 5.12 yields

k = 1.2 percent and 2k = 2.4 percent.

In equation 5.7: A = 1.00
B = -0.0364
R = 0.948

Replacing these values in equations 5.0 and 5.11 yields

S = 0.843 and I = 0.060

and the final equation becomes

$$Y = (0.843)Xmc + 0.060 \qquad (6.2)$$

with the 95 percent confidence interval equation to 2.4 percent air content.

The points (Xmc, PMR) and their corresponding best fit straight line, equation 5.5, are illustrated by Fig. 6.2. Here also the mortar corrected readings give higher values of air content than the actual values represented by the PMR. Hence the need to adjust these readings through the use of equation 6.2. The same final remark in 6.1 applies here.

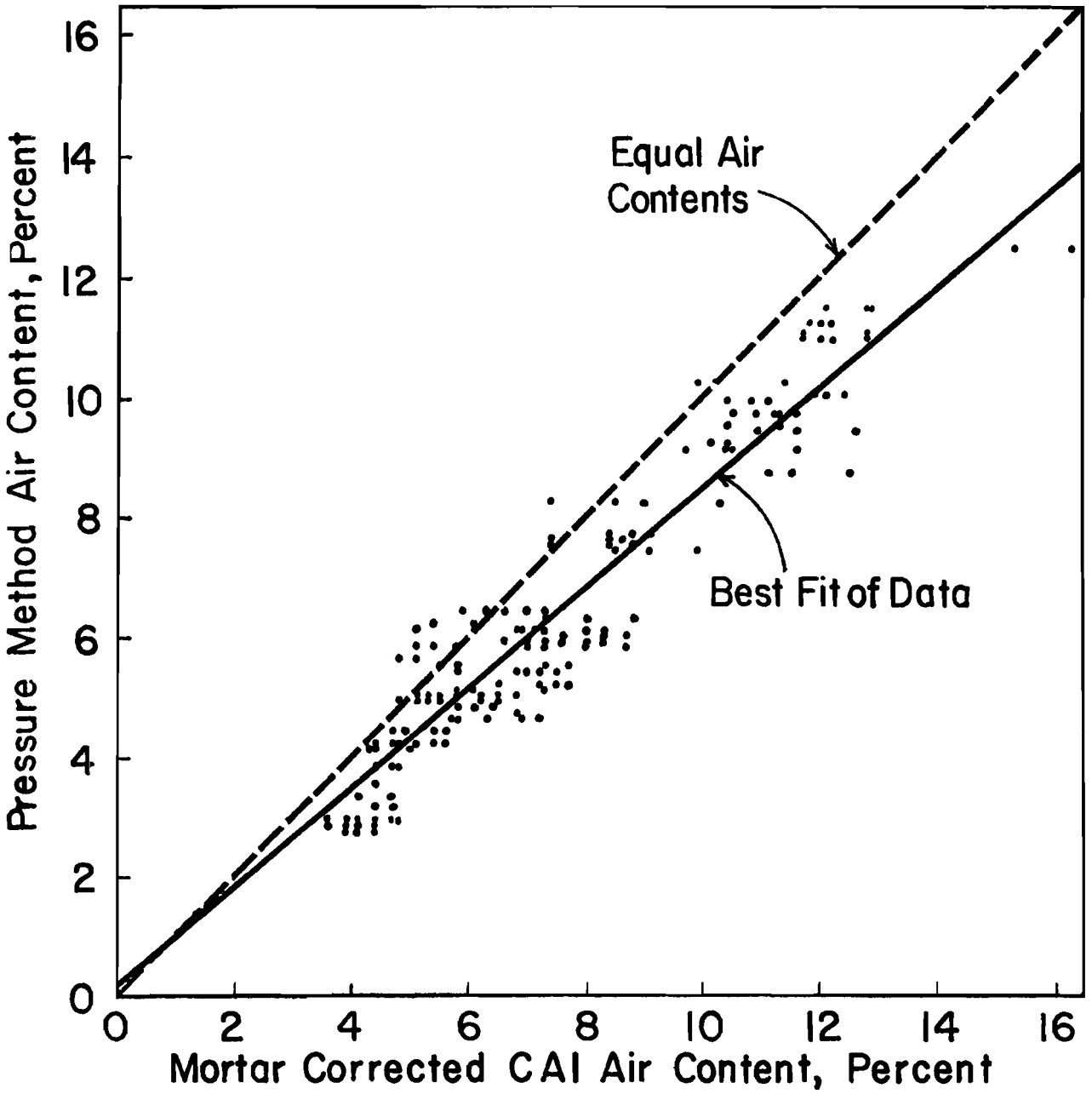

Fig. 6.3 Best Fit Straight Line and Scatter of Points for Mortar Corrected Average of Three CAI Readings

6.1.3 Results Using Average of Three CAI Readings

Taking the average of the three readings with each CAI and performing the regression analysis as described in Section 5.5 gives the following results.

In equation 5.5: a1 = 0.850
b1 = 0.00599
R = 0.951

In equation 5.6: a2 = -0.00315
b2 = 0.0255
R = -0.0097

The mean value for (PMR - Y1) was found to be equal to 0.0056, the related sigma equal to 0.78, and the corresponding n equal to 3. Replacing sigma and n by their values in equation 5.12 yields

k = 0.9 percent and 2k = 1.8 percent.

In equation 5.7:

A = 0.995

B = 0.0325

R = 0.951

Replacing these values in equation 5.10 and 5.11 yields

S = 0.844 and I = 0.064

and the final equation becomes

$$Y = (0.844)Xmc + 0.064 \qquad (6.3)$$

with the 95 percent confidence interval equal to 1.8 percent air content.

The points (Xmc, PMR) and their corresponding best fit straight line, equation 5.5 are illustrated by Fig. 6.3. Here again the mortar corrected readings give higher values of air content than the actual values represented by the PMR, hence the need to adjust these readings through the use of equation 6.3. The same final remark in 6.1 applies here also.

Table E.1 represents a sample of the regression analysis calculations performed on the average of three CAI readings for variable HS.

The process of using equation 5.9 to correct the Xmc is called curve correction.

Fig. E1 illustrates how mortar corrected CAI readings used in Section 6.3 compare with the corresponding PMR for all 16 variables. The lowest, highest, and average value for Xmc and PMR are also shown. These figures show that for all seven variables the average Xmc is higher than the corresponding PMR.

6.1.4 Comparison with Previous Results

Sprinkel (3) found a relationship relating Y to Xmc. That relationship is identical to equation 5.9 and is given by

$$Y = (1.164)Xmc - 0.308 \qquad (6.4)$$

with the 95 percent confidence interval equal to 3.8 percent air content.

Using this equation a new set of points (Xmc, Y) was found and the best fit straight line was determined for the points (Y, PMR). This straight line is similar to equation 5.7.

Fig. 6.4 illustrated equation 5.7 as determined in the present study and as determined through the use of equation 6.4 for the readings used in 6.1. The corresponding confidence intervals are also shown in this figure. Similarly, Figs. 6.5 and 6.6 illustrate equation 5.7 for the readings used in 6.2 and 6.3 respectively.

6.2 Instrument Variability

6.2.1 CAI Variability

The CAI variability is expressed as a percent error between instruments used by a single operator. Instrument variability was 2.3 percent for operator 1 and 3.6 percent for operator 2.

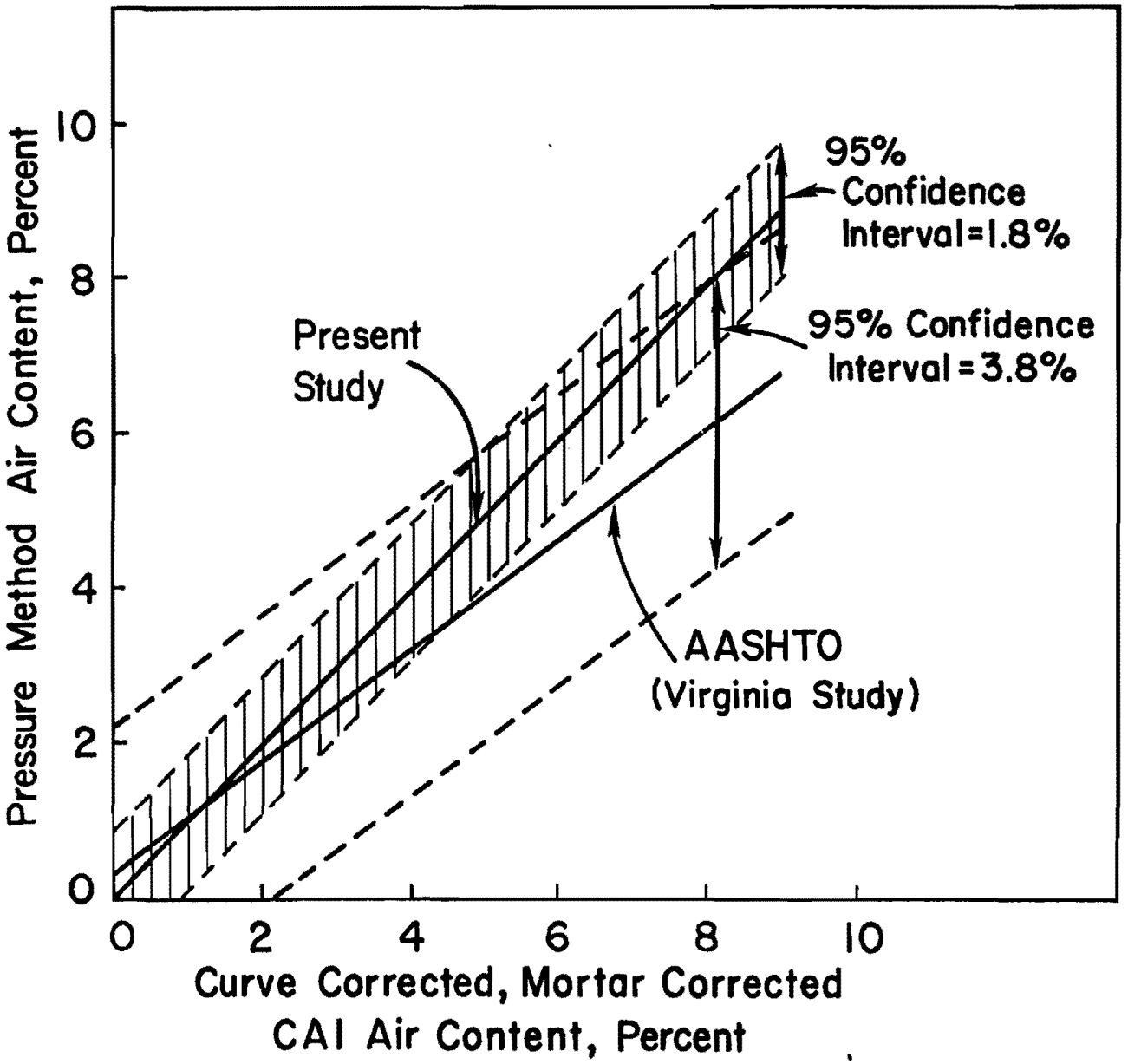

Fig. 6.4 Comparison of Best Fit Straight Lines for First CAI Reading

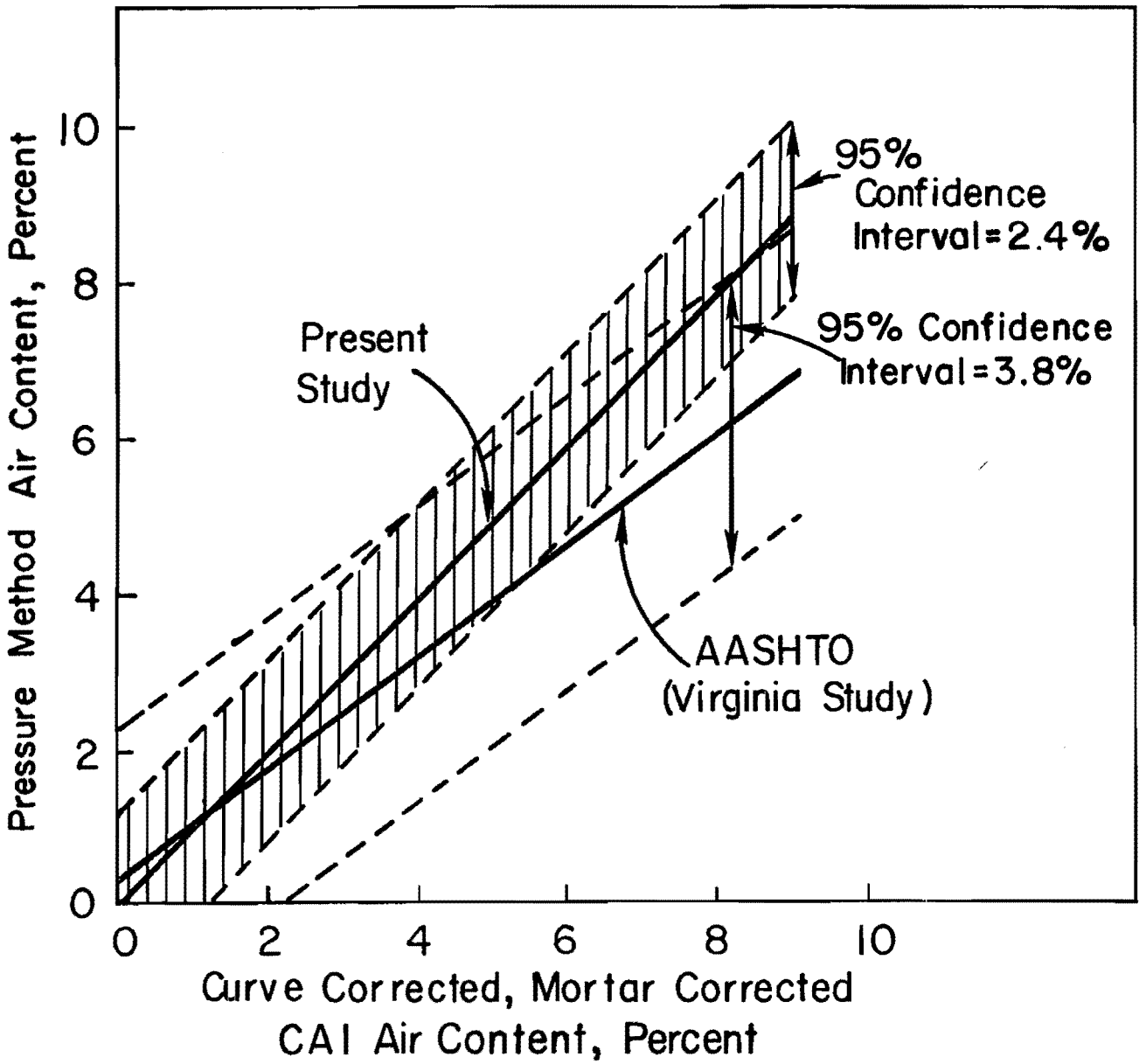

Fig. 6.5 Comparison of Best Fit Straight Lines for Average of First Two CAI Readings

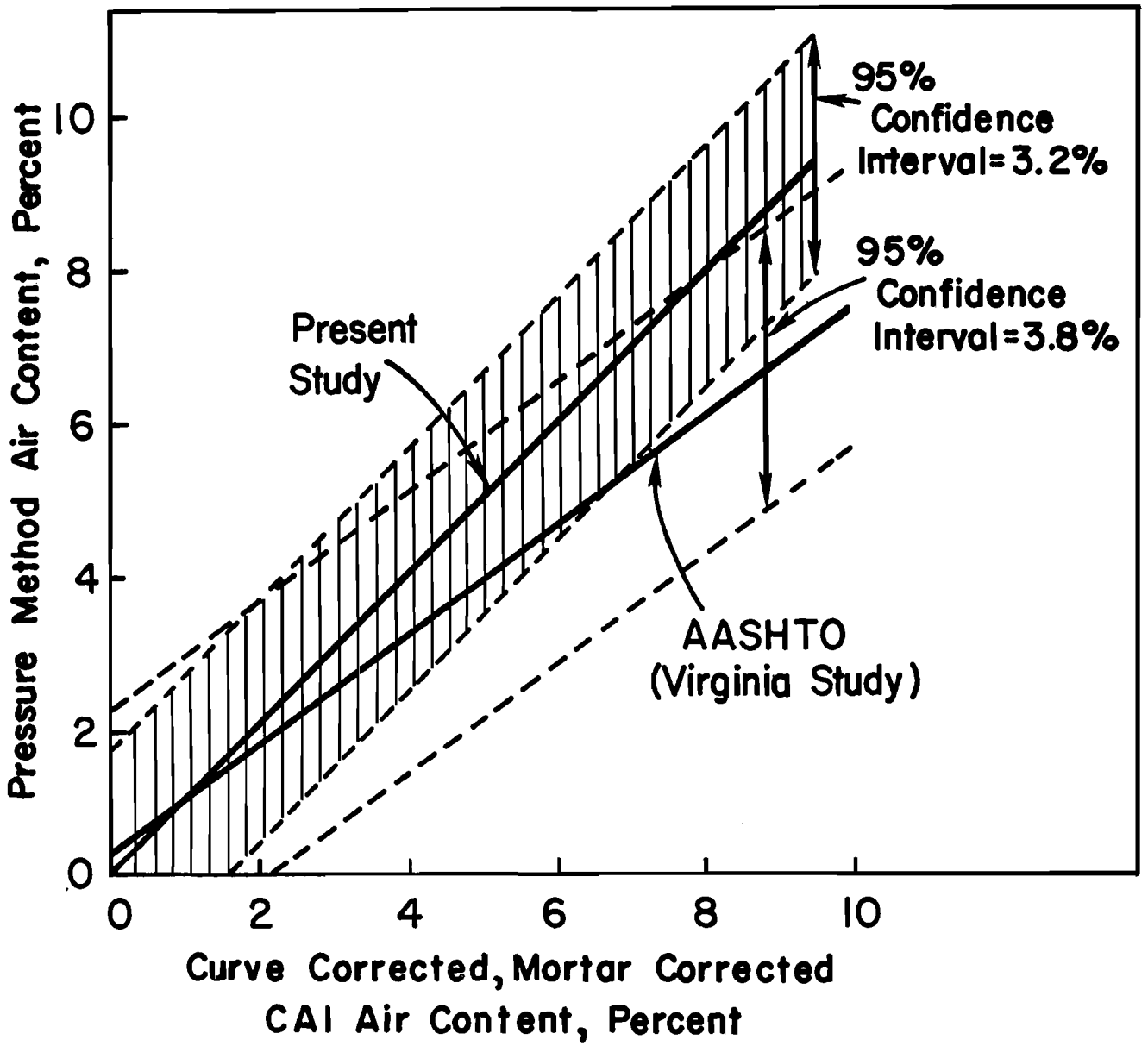

Fig. 6.6 Comparison of Best Fit Straight Lines
for Average of Three CAI Readings

6.2.2 Pressure Meter Variability

The variability between pressure meters was 4.1 percent as opposed to a variability within each instrument of 4.3 percent for pressure meter 1, 4.2 percent for pressure meter 2 and 4.8 percent for pressure meter 3.

6.3 Operator Variability

Operator variability can be expressed as a percent error in reading using one instrument only. Operator variability was 1.2 percent for CAI 2, 4.1 percent for CAI 3 and 3.8 percent for CAI 4.

6.4 Summary of Instrument and Operator Variability

It can be observed that operator and instrument variabilities are negligible. The similar variability for the CAI and the pressure meter does not imply that the CAI is as variable as the pressure meter.

The low values of the averages of the coefficient of variation for the CAIs and the operator variability using them might suggest that the CAI has the same variability as the PM. However, there are two reasons for the magnitude of these averages. First, the readings on the CAI were taken to the nearest half graduation, whereas the PM readings were taken to the nearest 0.1 percent air content. Second, with the PM, single readings were used, whereas, with the CAI, the averages of three readings were used, which introduces a $\sqrt{n}$ factor in the calculation of the standard deviation for the CAI readings. All the values of coefficients of variation are not statistically significant.

CHAPTER 7

SUMMARY AND CONCLUSIONS

7.1 Summary

The objectives of the study were:

(1) Determine if the Chace Air Indicator (CAI) is sufficiently accurate for job control purposes.

(2) Identify limits or tolerances for the projected use.

(3) Determine the calibration and correlation requirements.

This study included tests to determine the effect of the following variables:

(1) Low slump

(2) Medium slump (which was the standard batch)

(3) High slump

(4) Low air content

(5) High air content

(6) Low temperature

(7) High temperature

(8) Cement type II

(9) Cement type III

(10) Water reducer at low air content

(11) Water reducer at high air content

(12) High range water reducer at low air content

(13) High range water reducer at high air content

(14) Siliceous coarse with limestone fine aggregates

(15) Limestone coarse with siliceous fine aggregates

(16) Limestone coarse with limestone fine aggregates

Seventy-eight batches were tested for air entrainment. On each batch, three readings from each of the three CAIs and one reading from each of the three pressure meters (PM) used were taken. Two operators performed the tests interchangeably. A total number of 1020 readings were taken.

Readings from all batches were used in finding a correlation between the results obtained from the CAI tests and those obtained from the PM tests. Two types of corrections were required for the CAI readings: first, a mortar correction, which takes into account the Chace Factor of the CAI used and the mortar content of the concrete tested, and second, a curve correction which takes into account the high value of the mortar corrected reading as compared to the PM reading. Three separate regression analyses were performed on the data to obtain the curve correction. In the first one, only the first reading from each CAI from each batch was used. In the second, the average of the three readings on each CAI was used. The three results were very close to each other and could be combined in just one final result.

The mortar correction used was the same as that developed in a previous study (3), whereas the curve correction is different from the one developed in this same study (3) and adopted by AASHTO (6).

7.2 Conclusions

(1) Each CAI should be inscribed with a Chace Factor, which is defined as the volume of one graduation on the stem as a percentage of the volume of the cup (3).

(2) A clear improvement of operator performance with repeated measurements was observed. The rapid learning curve suggested that a short period of training would significantly improve repeatability of results.

(3) Operator and instrument variabilities were negligible.

(4) The CAI indicated higher values than the pressure meter at low air contents and lower values at high air contents, which confirmed results of previous studies (2 and 3).

(5) Two types of correction should be applied to the CAI reading: first, the mortar correction of the reading, which takes into account the Chace Factor and the mortar content of the concrete, and second, the curve correction of the mortar corrected reading, which takes into account the high value of the mortar corrected reading as compared to the pressure meter reading.

(6) The mortar correction is applied to the uncorrected CAI reading or average of readings through the use of equation 7.1:

$$Xmc = \frac{(CF)(MC)}{27} (Xu) \qquad (7.1)$$

where

Xmc = mortar corrected reading,

Xu = uncorrected CAI reading or average of readings,

CF = Chace Factor of the CAI used,

MC = mortar content in the concrete, expressed in cu ft/cu yd.

(7) Mortar-corrected CAI readings were higher than pressure meter readings over all ranges of air content.

(8) A curve correction of the form $y = 0.842\ Xmc + 0.064$ was obtained, where y is the actual air content and Xmc is the mortar-corrected CAI reading.

(9) The correction to be applied was identical if one or more readings per sample were performed on the same batch. The difference was in the confidence interval, indicating the reliability of results: the 95 percent confidence interval decreased from 3.2 percent to 1.8 percent as the number of readings increased from 1 to 3.

(10) Suggested modifications to the existing procedure can improve the accuracy and precision of results. These are presented in detail in Section 4.3.

(11) The CAI could be used to provide a reasonably accurate measurement of the air content of fresh concrete. The procedure could consist of one reading, or the average of two or three readings.

(12) Comparison of results with previously established corrections indicates a notable improvement. The confidence intervals were reduced and the best fit line of data became almost identical to the line of equality between the pressure meter and the CAI.

(13) It was observed that addition of high range water reducer at high air content resulted in decreasing air content with time as measured by both the CAI and the pressure meter. Air contents measured with either device cannot be considered accurate under these circumstances.

7.3 Recommendations

Laboratory results in this study should be combined with results of a field study to determine correlation requirements between the CAI and the pressure meter.

During the laboratory phase, testing was performed under very controlled conditions. Before any implementation of results, testing in the field should be performed. The field phase will illustrate the applicability of the conclusions of this laboratory phase for the use of the CAI for construction control.

Future studies might include more testing for concretes with high range reducer at high air content.

APPENDIX A

MATRIX OF VARIABLES AND TEST DATA SHEETS

Table A.1. Matrix of Variables

Main Variables			Design Constants						
			SLUMP			AIR CONTENT			AGGREGATES
			Low	Med.	High	Low	Med.	High	SC/SF
	SLUMP	Low					X		X
		Med.					X		X
		High					X		X
	AIR CONTENT	Low		X					X
		Med.		X					X
		High		X					X
	TEMP.	50 F			X			X	X
		100 F			X			X	X
	CEMENT	II		X			X		X
		III		X			X		X
	AGGREGATES	LC/LF		X			X		
		LC/SF		X			X		
		SC/LF		X			X		
		SC/SF		X			X		
	ADMIXTURES			X		X			X
				X				X	X
					X	X			X
					X			X	X

where:

LC = limestone coarse
LF = limestone fine
SC = silicious coarse
SF = silicious fine

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 23 / 83	VARIABLE TESTED: LOW SLUMP	BATCH NO: LS 1
AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	+0.1%	95	3	Silicious	148.5	0.78
FA	2.59	0.8%	+2.5%	•	1	Silicious	73.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs.	18.1 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3"	1-3" (low)
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6 ± 1% (Mixing time = 2.0 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		4.5	5.0	4.5	MAZEN JABRI
			4.0	4.5	4.5	
			4.5	4.5	4.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	5.0%	4.9%	4.9%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 23 / 83	VARIABLE TESTED: LOW SLUMP	BATCH NO: LS 2

AMBIENT TEMPERATURE: 77°F	RELATIVE HUMIDITY: 53%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	+0.1%	95	3	Silicious	148.5	0.78
FA	2.59	0.8%	+2.5%		1	Silicious	73.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0	6

WATER	Design weight	Net Weight (after correction)	w/c
	19.0 lbs.	17.5	0.45

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	30.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	2 1/4"	1-3"
Strength	(28-day) 5620 psi	(28-day) > 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6 + 1% (Mixing time = 3.0 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		4.5	4.0	4.0	AMR TABBARAH
			4.5	4.5	4.5	
			5.0	4.0	4.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	4.8%	4.5%	4.7%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 23 / 83	VARIABLE TESTED: LOW SLUMP	BATCH NO: LS 3

AMBIENT TEMPERATURE: 77°F	RELATIVE HUMIDITY: 53%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	+0.1%	95	3	Silicious	148.5	0.78
FA	2.59	0.8%	+2.5%		1	Silicious	76.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.9	16.8	0.45

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	30.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	1 3/4"	1-3" (low)
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	Medium (	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		3.5	3.5	3.0	MAZEN JABRI
			4.0	3.5	3.5	
			3.5	3.0	3.0	
	OP3				5.5	LEROY
					4.5	
					3.5	

PRESS-UR METER	PM	P1 D-9	P2	P3	D-9
	OP_1		4.3	4.0	4.4 Amr Tabbarah
	OP_2	4.3			4.4 Leroy

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 25 / 83	VARIABLE TESTED: LOW SLUMP	BATCH NO: LS 4

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.8%	95	3	Silicious	149.5	0.78
FA	2.59	0.8%	3.0%		1	Silicious	76.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	1	42.0	6

WATER	Design weight	Net Weight (after correction)	w/c
	19.8 lbs.	16.5	0.47

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	40.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	1 1/4"	1-3" (low slump)
Strength	(28-day) 6050 psi	(28-day) >3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6 ± 1% (Mixing time = 3.0 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		5.0	5.0	5.0	AMR TABBARAH
			5.0	5.0	5.0	
			5.0	5.0	5.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP2	4.8%	5.0%	4.7%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 25 / 83	VARIABLE TESTED: LOW SLUMP	BATCH NO: LS 5

AMBIENT TEMPERATURE: 76° F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.8%	95	3	Silicious	149.5	0.78
FA	2.59	0.8%	3.0%		1	Silicious	76.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	1	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.5 lbs.	17.0 lbs.	0.49

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	50.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	1 1/4"	1-3"
Strength	(28-day) 5320 psi	(28-day) >3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6 ± 1% (Mixing time = 3 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		5.0	5.0	5.0	MAZEN JABRI
			5.0	5.0	5.0	
			5.5	5.0	5.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	6.5%	6.0%	6.2%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 7 / 83	VARIABLE TESTED: MEDIUM SLUMP	BATCH NO: MS 1
AMBIENT TEMPERATURE: 74°F	RELATIVE HUMIDITY: 47%	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.3%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+3.9%	•	1	Silicious	85.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	17.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 1/4"	3-5" (medium)
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1	3.5	2.5	3.5		AMR TABBARAH
		4.0	4.0	4.0		
		3.0	3.5	3.0		
	OP2	3.0	3.0	3.0		MAZEN JABRI
		3.5	4.0	3.5		
		4.0	3.5	4.0		
	OP3			3.5		
				2.0		
				4.5		

PRESS-UR METER	PM	P1	P2	P3	
	OP 1		5.5%	5.8%	Amr Tabbarah
	OP 2	6.5%			Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 9 / 83	VARIABLE TESTED: MEDIUM SLUMP	BATCH NO: MS 2

AMBIENT TEMPERATURE: 74° F	RELATIVE HUMIDITY: 47%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	+0.1%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	+3.1%	•	1	Silicious	85.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	17.4 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	5"	3-5" (medium)
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1	4.5	3.0	3.5		AMR TABBARAH
		3.5	3.5	4.0		
		4.0	4.0	4.5		
	OP2	4.0	4.0	3.0		MAZEN JABRI
		4.0	4.0	3.5		
		4.0	3.0	4.0		
	OP3	4.0				DAVID MACADAM
		3.5				
		4.0				

PRESS-UR METER	PM	P1	P2	P3	
	OP 1			5.9%	Amr Tabbarah
	OP 2	5.9%	5.8%		Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 15 / 83	VARIABLE TESTED: MEDIUM SLUMP	BATCH NO: MS 3

AMBIENT TEMPERATURE: 74° F	RELATIVE HUMIDITY: 58%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.2%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+3.6%		1	Silicious	85.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	17.4 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5"
Strength	(28-day) 4950 psi	(28-day) > 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 3 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		3.5	4.0	3.5	AMR TABBARAH
			4.0	4.0	3.0	
			4.0	4.0	4.0	
	OP2		3.5	4.0	4.0	MAZEN JABRI
			4.0	3.0	3.5	
			3.5	4.0	4.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	5.2%	5.0%		Amr Tabbarah
	OP 2			5.2%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 6 / 83	VARIABLE TESTED: MEDIUM SLUMP	BATCH NO: MS 4

AMBIENT TEMPERATURE: 73° F	RELATIVE HUMIDITY: 58%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.0%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	3.9%		1	Silicious	85.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	1	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs.	16.8 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5"
Strength	(28-day) 4990 psi	(28-day) > 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		4.0	3.5	4.0	AMR TABBARAH
			3.5	4.0	3.0	
			3.5	4.0	3.5	
	OP2		3.5	3.5	3.5	MAZEN JABRI
			4.0	3.5	3.5	
			4.0	4.0	3.0	
	OP3			3.0		DAVID MACADAM
				3.0		
				3.0		

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	5.0 %			Amr Tabbarah
	OP 2		5.0%	5.0%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 6 / 83	VARIABLE TESTED: MEDIUM SLUMP	BATCH NO: MS 5
AMBIENT TEMPERATURE: 73° F	RELATIVE HUMIDITY: 58%	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.0%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	+3.9%		1	Silicious	85.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs.	16.8 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		5.0	4.5	4.5	AMR TABBARAH
			3.5	4.5	4.5	
			4.5	4.0	5.0	
	OP2		4.5	4.0	4.0	MAZEN JABRI
			4.0	3.0	4.5	
			4.0	4.5	4.5	
	OP3			4.5		KEVIN SMITH
				2.0		
				4.0		

PRESS-UR METER	PM	P1	P2	P3	
	OP 1		4.9%	5.0%	Amr Tabbarah
	OP 2	5.3%			Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 28 / 83	VARIABLE TESTED: HIGH SLUMP	BATCH NO: HS 1
AMBIENT TEMPERATURE: 75° F	RELATIVE HUMIDITY: 52%	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.2%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+2.5%		1	Silicious	73.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	45.5 lbs.	6.5

WATER	Design weight	Net Weight (after correction)	w/c
	23.0 lbs.	21.5 lbs.	0.51

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	6 1/2 "	5-8 "
Strength	(28-day) 4900 psi	(28-day) >3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		5.0	5.5	5.0	AMR TABBARAH
			5.0	5.0	5.5	
			5.0	5.0	5.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	5.1%	5.4%	5.4%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 28 / 83	VARIABLE TESTED: HIGH SLUMP	BATCH NO: HS 2
AMBIENT TEMPERATURE: 75° F	RELATIVE HUMIDITY: 52%	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.2%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+2.5%		1	Silicious	73.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	45.5 lbs.	6.5

WATER	Design weight	Net Weight (after correction)	w/c
	23.0 lbs.	21.5 lbs.	0.51

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	8"	5-8"
Strength	(28-day) 4920 psi	(28-day) > 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		5.0	5.0	5.5	MAZEN JABRI
			5.0	5.5	5.0	
			5.0	5.0	5.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	6.1%	5.8%	6.0%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3/ 28 / 83	VARIABLE TESTED: HIGH SLUMP	BATCH NO: HS 3

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 52%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.2%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+2.5%		1	Silicious	73.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	45.5	6.5

WATER	Design weight	Net Weight (after correction)	w/c
	23.0	21.5	0.51

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	7 3/4"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2 cubic feet	
Design Air Content	6% ±1 (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		5.5	5.5	5.5	AMR TABBARAH
			5.5	5.5	6.0	
			5.5	5.5	5.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP2	6.0%	6.0%	6.0%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 30 / 83	VARIABLE TESTED: HIGH SLUMP	BATCH NO: HS 4

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 63%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.2%	95	3	Silicious	137 lbs.	0.72
FA	2.59	0.8%	2.4%	"	1	Silicious	73.5 lbs.	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	45.5 lbs.	6.5

WATER	Design weight	Net Weight (after correction)	w/c
	23.0 lbs.	21.0 lbs.	0.51

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	7"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2 cubic feet	
Design Air Content	6% ± 1 (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		5.0	5.0	5.0	MAZEN JABRI
			5.5	5.0	5.0	
			5.5	5.0	5.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	5.7%	5.5%	5.7%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 30 / 83	VARIABLE TESTED: HIGH SLUMP	BATCH NO: HS 5

AMBIENT TEMPERATURE: 75° F	RELATIVE HUMIDITY: 63%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.2%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	2.4%		1	Silicious	73.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	1	45.5	6.5

WATER	Design weight	Net Weight (after correction)	w/c
	23.0 lbs.	21.0 lbs.	0.51

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	7 1/2"	5-8"
Strength	(28-day) 4920 psi	(28-day) 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% 1% (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		5.0	5.0	5.0	AMR TABBARAH
			5.0	5.0	5.5	
			5.0	5.0	5.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	5.5%	5.5%	5.6%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3/ 9 / 83	VARIABLE TESTED: LOW AIR CONTENT	BATCH NO: LA 1

AMBIENT TEMPERATURE: 74° F	RELATIVE HUMIDITY: 47%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	+0.1%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	+3.1%		1	Silicious	85.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	17.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 3/4"	3-5" (medium)
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	3.5% ± 1% (Mixing time)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1	4.0	3.5	3.5		AMR TABBARAH
		4.0	4.0	4.5		
		3.5	4.0	3.5		
	OP2	3.5	3.5	3.5		MAZEN JABRI
		3.0	3.5	3.0		
		3.0	4.0	3.5		
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	4.3%	4.4%		Amr Tabbarah
	OP 2			4.7%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 5 /83	VARIABLE TESTED: LOW AIR CONTENT	BATCH NO: LA 2

AMBIENT TEMPERATURE: 74° F	RELATIVE HUMIDITY: 58%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.2%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+3.6%		1	Silicious	85.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs.	17.4 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3"	3-5"
Strength	(28-day) 5590 psi	(28-day) ≥3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	35% ± 1% (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1	4.0	4.0	3.5		AMR TABBARAH
		3.5	3.5	3.5		
		4.0	3.5	3.5		
	OP2	3.5	3.0	3.5		MAZEN JABRI
		3.5	3.5	3.0		
		3.0	3.5	3.5		
	OP3			3.5		DAVID MACADAM
				3.0		
				3.0		

PRESS-UR METER	PM	P1	P2	P3	
	OP 1			4.2	Amr Tabbarah
	OP 2	4.3	4.3		Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3/ 21 / 83	VARIABLE TESTED: LOW AIR CONTENT	BATCH NO: LA 3

AMBIENT TEMPERATURE: 74° F	RELATIVE HUMIDITY: 40%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	+0.1%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	+3.2%		1	Silicious	92.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.9 lbs.	17.9 lbs.	0.50

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	10.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5 " (Medium)
Strength	(28-day)	(28-day)
Batch volume		
Design Air Content	3 + 1% (Mixing time = 2 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		3.5	3.5	3.5	AMR TABBARAH
			3.0	3.0	3.0	
			3.0	3.0	3.5	
	OP2		3.0	3.0	3.0	MAZEN JABRI
			3.0	3.0	3.0	
			3.5	3.0	3.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	4.5%	4.0%		Amr Tabbarah
	OP 2			4.3%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3 / 21 / 83	VARIABLE TESTED: LOW AIR CONTENT	BATCH NO: LA 4

AMBIENT TEMPERATURE: 74°F	RELATIVE HUMIDITY: 40%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	+0.1%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	+3.2%		1	Silicious	92.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	1	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.9 lbs.	17.9 lbs.	0.5

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	6.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 1/2 "	3-5"
Strength	(28-day) 5910 psi	(28-day) >3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	3 ± 1% (Mixing time + 2.5 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		3.0	3.0	3.0	AMR TABBARAH
			3.5	3.0	2.5	
			3.0	3.0	3.0	
	OP2		3.0	2.5	2.5	MAZEN JABRI
			3.0	2.5	2.5	
			3.0	3.0	2.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	3.3%			Amr Tabbarah
	OP 2		3.0%	2.7%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 3/ 21 / 83	VARIABLE TESTED: LOW AIR CONTENT	BATCH NO: LA 5

AMBIENT TEMPERATURE: 74° F	RELATIVE HUMIDITY: 40%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	+0.1%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	+3.2%		1	Silicious	92.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.9 lbs.	17.9 lbs.	0.50

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	6.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	2 1/2"	
Strength	(28-day)	(28-day)
Batch volume		
Design Air Content	3 ± 1 (Mixing time = 3 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		3.0	3.0	3.0	AMR TABBARAH
			3.0	3.0	3.0	
			3.0	3.0	3.0	
	OP2		3.0	2.5	2.5	MAZEN JABRI
			3.0	2.5	2.5	
			3.0	2.5	3.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP1			2.8%	Amr Tabbarah
	OP2	2.9%	2.9%		Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 1 / 83	VARIABLE TESTED: HIGH AIR	BATCH NO: HA 1

AMBIENT TEMPERATURE: 73°F	RELATIVE HUMIDITY: 62%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.35%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+3.6%		1	Silicious	72.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.5	18.5	0.49

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	70.0	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 3/4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10% + 1 (Mixing time = 5 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBAKAH
	OP2		8.0	8.0	8.0	MAZEN JABRI
			8.0	8.5	8.0	
			8.0	8.0	8.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	11.5%	11.0%	11.4%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 4 / 83	VARIABLE TESTED: HIGH AIR	BATCH NO: HA 2

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 78%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.2%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+2.8%		1	Silicious	71.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0	18.5	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	50.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5"
Strength	(28-day) 4310 psi	(28-day) 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	10% + 1 (Mixing time = 2.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		8.0	8.0	7.5	AMR TABBARAH
			8.0	7.5	7.5	
			8.0	8.0	8.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	------	9.8%	9.8%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 4 / 83	VARIABLE TESTED: HIGH AIR	BATCH NO: HA 4

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 78%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.2%	45	3	Silicious	136.5	0.72
FA	2.59	0.8%	+2.8%	•	1	Silicious	71.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	18.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	45.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 3/4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2 cubic feet	
Design Air Content	10% + 1 (Mixing time = 2.0 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1		7.0	7.5	7.0	AMR TABBARAH
			7.5	7.0	7.0	
			7.5	7.0	7.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	9.0	9.1	9.5	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4/ 4 / 83	VARIABLE TESTED: HIGH AIR	BATCH NO: HA 5

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 78%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.2%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+2.8%	•	1	Silicious	71.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	18.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	46.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4" -	3-5"
Strength	(28-day)	(28-day)
Batch volume	2 cubic feet	
Design Air Content	10% ± 1 (Mixing time = 2.0 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		7.0	7.0	7.0	MAZEN JABRI
			7.0	7.5	7.5	
			7.0	7.0	7.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	9.0%	9.2%	9.6%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 19 / 83	VARIABLE TESTED: LOW TEMPERATURE	BATCH NO: LT 1

AMBIENT TEMPERATURE: 54°F	RELATIVE HUMIDITY: 81%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.0%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	0.66%		1	Silicious	83.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	19.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	28.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	5 1/4"	5-8"
Strength	(28-day) 3660 psi	(28-day) ≥3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	10.0% ± 1 (Mixing time = 3 min.)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	8.0	8.0		8.0	MAZEN JABRI
		8.0	8.0		8.0	
		8.0	8.0		8.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP1	11.0%	11.0%	10.5%	Amr Tabbarah

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 19 / 83	VARIABLE TESTED: LOW TEMPERATURE	BATCH NO: LT 2

AMBIENT TEMPERATURE: 54°F	RELATIVE HUMIDITY: 81%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.0%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	0.61%		1	Silicious	83.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	19.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	28.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	5 1/2"	5-8"
Strength	(28-day) 3770 psi	(28-day) >3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	10.0% + 1 (Mixing time = 3 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	8.0	8.5		8.5	AMR TABBARAH
		8.5	8.0		8.5	
		8.0	8.5		8.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 19 / 83	VARIABLE TESTED: LOW TEMPERATURE	BATCH NO: LT 3

AMBIENT TEMPERATURE: 54°F	RELATIVE HUMIDITY: 81%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.0%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	0.66%		1	Silicious	83.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	19.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	28 g.	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 3/4"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	7.0	7.5		7.5	MAZEN JABRI
		7.5	8.0		8.0	
		7.0	8.0		8.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP1	9.6%	9.6%	9.1%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 20 / 83	VARIABLE TESTED: LOW TEMPERATURE	BATCH NO: LT 4

AMBIENT TEMPERATURE: 53°F	RELATIVE HUMIDITY: 81%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.14%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+2.86%		1	Silicious	84.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	17.9 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	28.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 3/4"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10.0% ± 1 (Mixing time = 3 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	8.5	9.0		9.0	AMR TABBARAH
		8.5	9.0		9.0	
		8.5	9.0		9.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP	10.0%	10.0%	9.5%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 20 / 83	VARIABLE TESTED: LOW TEMPERATURE	BATCH NO: LT 5

AMBIENT TEMPERATURE: 53°F	RELATIVE HUMIDITY: 81%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.14%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+2.86%		1	Silicious	84.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	17.9 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	28.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	7 3/4"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10% ± 1 % (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	8.0	8.5		8.5	MAZEN JABRI
		8.5	9.0		9.0	
		8.5	8.5		8.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP1	11.0%	11.0%	10.7%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 21/ 83	VARIABLE TESTED: HIGH TEMPERATURE	BATCH NO: HT 1

AMBIENT TEMPERATURE: 102°F	RELATIVE HUMIDITY: 90%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.5%	95	3	Silicious	137.5	0.72
FA	2.59	0.8%	3.46%		1	Silicious	66.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	22.1 lbs.	19.3 lbs.	0.53

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	70.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHASE AIR INDICATOR	OP1	9.0	9.0		9.0	AMR TABBARAH
		8.5	9.0		9.0	
		8.5	9.0		8.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	10.1%	10.0%	9.6%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 21 / 83	VARIABLE TESTED: HIGH TEMPERATURE(100°F)	BATCH NO: HT 2

AMBIENT TEMPERATURE: 102°F	RELATIVE HUMIDITY: 90%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.5%	95	3	Silicious	137.5	0.72
FA	2.59	0.8%	3.46%		1	Silicious	66.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	22.1 lbs.	19.3 lbs.	0.53

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	70.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 3/4"	5-8"
Strength	(28-day) 3980 psi	(28-day) >3600 psi
Batch volume		
Design Air Content		

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	7.5	9.0		8.0	MAZEN JABRI
		7.5	8.5		8.0	
		7.5	8.5		8.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	10.0%	9.5%	8.5%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 21 / 83	VARIABLE TESTED: HIGH TEMPERATURE (100°F)	BATCH NO: HT 3

AMBIENT TEMPERATURE: 102°F	RELATIVE HUMIDITY: 90%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.17%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	2.31%		1	Silicious	65.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	22.1 lbs.	20.4 lbs.	0.53

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	70.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHASE AIR INDICATOR	OP1	8.0	8.5		8.0	AMR TABBARAH
		7.5	9.0		8.0	
		7.5	8.5		8.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	9.5%	8.8%	8.8%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 22 / 83	VARIABLE TESTED: HIGH TEMPERATURE(100°F)	BATCH NO: HT 4

AMBIENT TEMPERATURE: 102°F	RELATIVE HUMIDITY: 90%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.17%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	2.31%		1	Silicious	65.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	22.1 lbs.	20.4 lbs.	0.53

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	75.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	5"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10% ± 1 (Mixing time = 3 min.)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	8.0	9.0		8.5	MAZEN JABRI
		8.0	8.5		8.5	
		8.5	9.0		9.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	11.6%	11.5%	10.7%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 22 / 83	VARIABLE TESTED: HIGH TEMPERATURE(100°F)	BATCH NO: HT 5

AMBIENT TEMPERATURE: 102°F	RELATIVE HUMIDITY: 90%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.17%	95	3	Silicious	137.0	0.72
FA	2.59	0.8%	2.31%		1	Silicious	65.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	22.1 lbs.	20.4 lbs.	0.53

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	70.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	5 1/2"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2 .0 cubic feet	
Design Air Content	10.0% ± 1 (Mixing time = 3 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	11.0	11.0		11.0	AMR TABBARAH
		10.0	11.0		11.0	
		10.0	11.0		11.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	4.0%	12.5%	11.5%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 11 / 83	VARIABLE TESTED: CEMENT TYPE II	BATCH NO: CII 1
AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 60%	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight lbs.	Factor
CA	2.62	0.5%	0.65%	95	3	Silicious	138.0	0.72
FA	2.59	0.8%	3.1%		1	Silicious	85	

CEMENT	Brand	Type	Weight	Factor
	CENTEX	II	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs. (20.5)	16.5 (17.0) lbs.	0.48 (0.49)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	23.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 1/4"	3-5"
Strength	(28-day) 4670 psi	(28-day) >3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 4.0 min.)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	4.5	5.0		5.0	AMR TABBARAH
		4.5	5.5		5.0	
		4.5	5.0		5.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	5.3%	5.2%	5.4%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 11/ 83	VARIABLE TESTED: CEMENT TYPE II	BATCH NO: CII 2

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 60%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	0.65%	95	3	Silicious	138	0.72
FA	2.59	0.8%	3.1%		1	Silicious	85	

CEMENT	Brand	Type	Weight	Factor
	CENTEX	II	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs. (20.5)	16.5 lbs. (17.0)	0.48 (0.49)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	23.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 1/4"	3-5"
Strength	(28-day) 4560 psi	(28-day) 7 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	5.0	4.5		5.0	MAZEN JABRI
		4.5	5.0		5.0	
		5.0	5.0		5.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	6.0%	5.8%	5.9%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 2 / 83	VARIABLE TESTED: CEMENT TYPE II	BATCH NO: CII 3

AMBIENT TEMPERATURE: 78°F	RELATIVE HUMIDITY: 53%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.05%	95	3	Silicious	137	0.72
FA	2.59	0.8%	+2.2%		1	Silicious	84	

CEMENT	Brand	Type	Weight	Factor
	CENTEX	II	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	18.3 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	23.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 1/2"	3-5"
Strength	(28-day) 4210 psi	(28-day) ≥ 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	5.0	5.0		5.0	MAZEN JABRI
		5.0	5.0		5.0	
		5.0	5.0		5.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	6.1 %	6.1%	5.9%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 6 / 83	VARIABLE TESTED: CEMENT TYPE II	BATCH NO: CII 4

AMBIENT TEMPERATURE:	75°F	RELATIVE HUMIDITY:	51%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-.37%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+1.25%		1	Silicious	83.5	

CEMENT	Brand	Type	Weight	Factor
	CENTEX	II	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20 lbs.	19.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	23.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	5"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1 (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	5.0	5.5		5.5	AMR TABBARAH
		5.0	5.5		5.5	
		5.0	5.5		6.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	6.3%	6.1%	6.1%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 16 / 83	VARIABLE TESTED: CEMENT TYPE II	BATCH NO: CII 5

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 51%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.37%	95.0	3	Silicious	136.5	0.72
FA	2.59	0.8%	+1.25%		1	Silicious	83.5	

CEMENT	Brand	Type	Weight	Factor
	CENTEX	II	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs	19.05 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	23.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	2"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 4.5 min.)	

MEASURED AIR CONTENT	CAI	C_5	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	4.5	4.5		4.0	MAZEN JABRI
		4.0	4.5		4.5	
		4.5	4.5		4.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	5.0%	5.0%	4.5%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 23/ 83	VARIABLE TESTED: CEMENT TYPE III	BATCH NO: C III 3

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight lbs.	Factor
CA	2.62	0.5%	-0.10%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+3.50%		1	Silicious	83.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	III	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.9 lbs.	18.2 lbs.	0.50

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	35.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 1/4"	3-5"
Strength	(7-day) 3940 psi	(7-day) $\geq$ 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% $\pm$ 1 % (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	5.0	6.0		5.5	AMR TABBARAH
		5.0	6.0		5.5	
		5.0	6.0		5.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	6.8%	6.4%	6.1%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 23 / 83	VARIABLE TESTED: CEMENT TYPE III	BATCH NO: C III 4

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.10%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+3.50%		1	Silicious	83.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	III	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.9 g	18.2 lbs.	0.50

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	35.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3"	3-5"
Strength	(7-day) 3610 psi	(7-day) ≥3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
C CHACE AIR INDICATOR	OP1	5.0	6.0		6.0	AMR TABBARAH
		5.5	6.0		5.5	
		5.0	6.0		5.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	6.3%	6.1%	6.0%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 23 / 83	VARIABLE TESTED: CEMENT TYPE III	BATCH NO: C III 2

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.10%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+3.50%		1	Silicious	83.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	III	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.9 lbs.	18.2 lbs.	0.50

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	35.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	2 1/2"	3-5 "
Strength	(28-day) 4370 psi	(28-day) 7 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	4.0	5.0		5.0	MAZEN JABRI
		4.0	4.5		4.5	
		4.0	5.0		4.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	6.0%	5.5%	5.4%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 23 / 83	VARIABLE TESTED: CEMENT TYPE III	BATCH NO: C III 4

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.10%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+3.50%		1	Silicious	83.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	III	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.5 lbs.	18.2 lbs.	0.50

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	35.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 1/4"	3-5 "
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C15	C2	C3	C4	
CHASE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	6.0	6.5		6.0	MAZEN JABRI
		5.5	6.0		6.0	
		5.5	6.0		6.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	8.2%	7.8%	7.8%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 24/ 83	VARIABLE TESTED: CEMENT TYPE III	BATCH NO: C III 5

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 59%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.8%	-0.36%	95	3	Silicious	136.5	0.72
FA	2.59	0.5%	+2.95%		1	Silicious	82.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	III	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.9 lbs.	19.0 lbs.	0.5

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	35.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHASE AIR INDICATOR	OP1	5.0	6.0		5.5	AMR TABBARAH
		5.0	6.0		5.5	
		5.0	6.0		5.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	5.8%	5.9%	6.0%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 5 / 83	VARIABLE TESTED: WATER REDUCER(A)low a	BATCH NO: WR1

AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.2%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	1.3%		1	Silicious	93.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	19.0 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	6.0g	SEPTAIR
Water Reducer (type A)	65 ml	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	2 1/4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	3% ± 1 (Mixing time = minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		3.0	3.0	3.0	MAZEN JABRI
			3.0	3.0	3.0	
			3.0	3.0	3.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	2.8	2.7	3.0	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 4 / 83	VARIABLE TESTED: WR LOW AIR	BATCH NO: WR LA 2

AMBIENT TEMPERATURE: 77°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.4%	95	3	Silicious	136	0.72
FA	2.59	0.8%	+1.4%		1	Silicious	93	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.(19.0)	19.5 (18.5)	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		
Water Reducer (type A)	2.0 Fl.oz.	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	2 1/2"	3-5"
Strength	(28-day) 6810 psi	(28-day) 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	3% ± 1% (Mixing time = 5.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		3.0	3.0	3.0	MAZEN JABRI
			3.0	3.5	3.0	
			3.5	3.0	2.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	3.5%	3.2%	3.4%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 4 / 83	VARIABLE TESTED: WR LOW AIR	BATCH NO: WR 3

AMBIENT TEMPERATURE: 77°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.59	0.5%	-0.4%	95	3	Silicious	136.0	0.72
FA	2.62	0.8%	1.4%		1	Silicious	93	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	19.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		
Water Reducer (type A)	2.0 fl. oz.	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	2 1/2"	
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	3% + 1% (Mixing time = 3.5 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1		3.0	3.5	3.0	AMR TABBARAH
			3.0	3.0	3.0	
			3.0	3.5	3.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	3.0 %	2.9%	3.0%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 8 / 83	VARIABLE TESTED: WR LOW AIR	BATCH NO: WR LA 4

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 44%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136	0.72
FA	2.59	0.8%	+1.4%		1	Silicious	93	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	19.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		
Water Reducer (type A)	2.0 Fl.oz.	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	2 3/4"	3-5"
Strength	(28-day) 6540 psi	(28-day) 7 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	3% ± 1% (Mixing time = 2.5 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	2.5	2.5		3.0	MAZEN JABRI
		2.5	3.0		2.5	
		3.0	3.0		3.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	2.9%	2.8%	2.8%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 8 / 83	VARIABLE TESTED: WATER REDUCER LOW AIR	NO: WR LA 5

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 44%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight lbs.	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136	0.72
FA	2.59	0.8%	+1.4%		1	Silicious	93	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	19.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		
Water Reducer (type A)	2 Fl.oz.	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3"	3-5"
Strength	(28-day) 6580 psi	(28-day) 7 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	3% + 1% (Mixing time = 2.5 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	3.0	3.0		3.0	AMR TABBARAH
		2.5	3.0		3.0	
		3.0	3.0		3.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	2.9%	2.9%	2.9%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 8 / 83	VARIABLE TESTED: W R HIGH AIR	BATCH NO: WR HA1

AMBIENT TEMPERATURE: 75° F	RELATIVE HUMIDITY: 44%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136	0.72
FA	2.59	0.8%	+1.4%		1	Silicious	70	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs. (19.2)	19.8 (19)	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	37.5 g	SEPTAIR
Water Reducer (type A)	2 fl. oz.	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	6"	medium slump
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	1.0% ± 1 (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1(5)	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	8.0	9.0		8.0	MAZEN JABRI
		8.0	9.0		8.0	
		8.0	8.0		8.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	11.1%	11.1%	11.2%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 10 / 83	VARIABLE TESTED: WR HIGH AIR	BATCH NO: WR HA 2

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 48%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.3%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	0.05%		1	Silicious	69.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs. (18.5)	20.5 lbs. (19.0)	0.48 (0.44)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	37 g	SEPTAIR
Water Reducer (type A)	2 Fl.oz.	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 1/4"	3-5"
Strength	(28-day) 4860 psi	(28-day) >3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	10% ± 1 % (Mixing time = 4.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	7.0	7.5		7.0	AMR TABBARAH
		6.0	7.0		7.5	
		6.0	7.0		7.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	8.2%	8.2%	8.5%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 10 / 83	VARIABLE TESTED: WR HIGH AIR	BATCH NO: WR HA 3

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 48%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.3%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+0.05%		1	Silicious	69.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20 lbs.(18.5)	20.5 lbs.(19.0)	0.48 (0.44)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	40.0 g	SEPTAIR
Water Reducer (type A)	2 Fl.oz.	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 3/4"	3-5"
Strength	(28-day) 4070 psi	(28-day) 3600 psi
Batch volume	2 cubic feet	
Design Air Content	10% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	7.5	8.0		7.5	MAZEN JABRI
		7.0	8.0		7.5	
		7.0	7.5		7.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP1	9.6%	9.7%	10.2%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 10 / 83	VARIABLE TESTED: WATER REDUCER HIGH AIR	BATCH NO: WR HA 4

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 48%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight lbs.	Factor
CA	2.62	0.5%	-0.3%	95	3	Silicious	136.5	0.72
FA	2.59	0.8%	+0.05%		1	Silicious	69.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20 lbs.(18.5)	20.5 lbs. (19.0)	0.48 (0.44)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	40.0 g	SEPTAIR
Water Reducer (type A)	2 Fl. oz.	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5"
Strength	(28-day) 4470 psi	(28-day) >3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	10% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	7.0	8.0		8.0	AMR TABBARAH
		6.5	8.0		8.0	
		6.5	8.0		8.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	9.1%	9.0%	9.4%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 10 / 83	VARIABLE TESTED: WATER REDUCER HIGH AIR	BATCH NO: WRHR 5

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 48%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.3%	95	3	Silicious	136	0.72
FA	2.59	0.8%			1	Silicious		

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs (18.5)	20.5 lbs. (19.0)	0.48 (0.44)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	40.0g	SEPTAIR
Water Reducer (type A)	2 Fl.oz.	POZZOLITH 322N
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump		
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10 + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C_5	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	6.5	8.0		7.0	MAZEN JABRI
		7.5	8.0		7.0	
		6.5	7.5		7.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	10.5%	10.4%	10.0%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 8 / 83	VARIABLE TESTED: HIGH RANGE WR (low air)	BATCH NO: HRWR 1

AMBIENT TEMPERATURE: 70°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight lbs.	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136 lbs.	0.72
FA	2.59	0.8%	1.6%		1	Silicious	97 lbs.	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.8 lbs.(17.8)	18.0 lbs. (17.0 lbs.)	0.45 (0.42)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		SEPTAIR
Water Reducer (type A)		
High Range Water Reducer	6.5 fl. oz. (185 ml)	POZZOLITH 400N

CONCRETE	Measured value	Design value
Slump	6 1/2 "	5-8" (high)
Strength	(28-day) 7130 psi	(28-day) >3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	3%+ 1 (Mixing time = 4.0 min)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1		3.0	3.0	3.0	AMR TABBARAH
			3.0	3.0	2.5	
			3.0	3.0	3.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	3.0%	2.5%	3.5%	Mazen Jabri

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 8 /83	VARIABLE TESTED: HIGH RANGE WR (low air)	BATCH NO: HRWR 2

AMBIENT TEMPERATURE: 70° F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136 lbs.	0.72
FA	2.59	0.8%	1.6%		1	Silicious	97 lbs.	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.8 lbs. (17.8)	18.0 lbs. (17.0)	0.45 (0.42)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		
Water Reducer (type A)		
High Range Water Reducer	6.5 fl.oz.(185 ml)	POZZOLITH 400N

CONCRETE	Measured value	Design value
Slump	4 1/4"	5-8"
Strength	(28-day) 7550 psi	(28-day) > 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	3.0% + 1 (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		3.0	3.0	3.0	MAZEN JABRI
			3.0	3.0	3.0	
			3.0	3.0	3.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	3.6%	3.8%	3.4%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 8 / 83	VARIABLE TESTED: HIGH RANGE WR (low air)	BATCH NO: HRWR 3

AMBIENT TEMPERATURE: 70°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136 lbs.	0.72
FA	2.59	0.8%	+1.6%	•	1	Silicious	97lbs.	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.8 lbs (18.3)	18.0 lbs. (17.5)	0.45 (0.43)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		
Water Reducer (type A)		
High Range Water Reducer	6.5 Floz(185 ml)	POZZ 400N

CONCRETE	Measured value	Design value
Slump	3 1/2"	
Strength	(28-day)	(28-day)
Batch volume	2 cubic feet	
Design Air Content	3% + 1 (Mixing time = 5 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1		3.0	3.0	3.0	AMR TABBARAH
			3.0	3.0	3.0	
			3.0	3.0	3.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP_2	3.3%	3.1%	3.2%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 8 / 83	VARIABLE TESTED: HIGH RANGE WR (low air)	BATCH NO: HRWR 4

AMBIENT TEMPERATURE: 70°	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	135 lbs.	0.72
FA	2.59	0.8%	+1.6%	•	1	Silicious	97 lbs.	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.8 lbs.(18.3)	18.0 lbs. (17.5)	0.45 (0.43)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		
Water Reducer (type A)		
High Range Water Reducer	6.5 Fl oz (185 ml)	POZZ 400N

CONCRETE	Measured value	Design value
Slump	5 1/2"	5-8"
Strength	(28-day)	(28-day)
Batch volume	2 cubic feet	
Design Air Content	3% ± 1 (Mixing time = 4 minutes)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		3.0	3.0	3.0	MAZEN JABRI
			3.5	3.5	3.5	
			3.0	3.5	3.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	4.0%	3.9%	3.9%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 29 / 83	VARIABLE TESTED: HRWR LOW AIR	BATCH NO: HRWR 5

AMBIENT TEMPERATURE: 80°F	RELATIVE HUMIDITY: 51%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.4%	95	3	Silicious	136.0	0.72
FA	2.59	0.8%	1.3%		1	Silicious	93.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.(18.5)	19.5 lbs. (18.0)	0.48(0.44)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		
Water Reducer (type A)		
High Range Water Reducer	6.5 Floz.	POZZOLITH 400N

CONCRETE	Measured value	Design value
Slump	7"	5-8"
Strength	(28-day) 6370 psi	(28-day) > 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	3 ± 1% (Mixing time = 2.5 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1		3.0	3.0	3.0	AMR TABBARAH
			3.0	3.0	3.0	
			3.0	3.0	3.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	3.0%	3.0%	3.0%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 29 / 83	VARIABLE TESTED: HIGH AIR HRWR	BATCH NO: HRWRH 1

AMBIENT TEMPERATURE: 80° F	RELATIVE HUMIDITY: 51%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.59	0.5%	-0.4%	95	3	Silicious	136.0	0.72
FA	2.62	0.8%	1.3%		1	Silicious	70.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs. (18.5)	19.5 (18.0)	0.48 (0.44)

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	30.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer	6.5 fl. oz.	POZZOLITH 400N

CONCRETE	Measured value	Design value
Slump	10"	
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10% + 1 (Mixing time = 2.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		5.5	5.5	5.0	MAZEN JABRI
			5.0	5.0	5.5	
			6.0	6.0	5.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	11.7%	11.1%	11.8%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 4 / 29 / 83	VARIABLE TESTED: HRWR HIGH AIR	BATCH NO: HRWRH 2

AMBIENT TEMPERATURE: 80°F	RELATIVE HUMIDITY: 51%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.4%	95	3	Silicious	136.0	0.72
FA	2.59	0.8%	1.3%		1	Silicious	70.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.	19.5 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	25.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer	6.5 fl. oz.	POZZOLITH 400N

CONCRETE	Measured value	Design value
Slump	8 3/4"	
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	10% + 1 (Mixing time = min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1		8.0	7.0	7.0	AMR TABBARAH
			8.0	6.5	6.0	
			8.0	6.0	6.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP2	10.0%	10.0%	9.9%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 2 / 83	VARIABLE TESTED: HRWR HIGH AIR	BATCH NO: HRWRH 3
AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.35%	95	3	Silicious	136.0	0.72
FA	2.59	0.8%	1.2%		1	Silicious	70.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs.(16.8)	19.7 lbs. (16.5)	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	30.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer	6.5 Fl. oz.	POZZOLITH 400N

CONCRETE	Measured value	Design value
Slump	7 1/2"	5-8"
Strength	(28-day) 5710 psi	(28-day) 7 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	10% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		8.5	8.0	8.0	MAZEN JABRI
			8.0	8.0	7.5	
			8.5	8.0	7.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	9.6%	8.8%	9.0%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 2 / 83	VARIABLE TESTED: HRWR HIGH AIR	BATCH NO: HRWR 4

AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.35%	95	3	Silicious	136.0	0.72
FA	2.59	0.8%	1.2%		1	Silicious	70.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 (16.8)	19.7 (16.5)	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer		
Water Reducer (type A)		
High Range Water Reducer	6.5 Fl. oz.	POZZOLITH 400N

CONCRETE	Measured value	Design value
Slump	8 1/4"	5-8"
Strength	(28-day) 5730 psi	(28-day) ⩾3600 psi
Batch volume	2 cubic feet	
Design Air Content	10% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1		10.0	8.0	7.0	AMR TABBARAH
			10.0	8.0	6.0	
			9.5	6.0	6.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	11.5%	8.9%	9.0%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 4 / 83	VARIABLE TESTED: HRWR HIGH AIR	BATCH NO: HRWRH 5

AMBIENT TEMPERATURE: 77°F	RELATIVE HUMIDITY: 56%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight lbs.	Factor
CA	2.62	0.5%	-0.4%	95	3	Silicious	136	0.72
FA	2.59	0.8%	+1.4%.		1	Silicious	70	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs. (16.5)	19.5 lbs. (16.0) lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	37 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer	6.5 Fl.oz.	POZZOLITH 400N

CONCRETE	Measured value	Design value
Slump	8 1/4"	5-8"
Strength	(28-day) 6985 psi	(28-day) 7 3600 psi
Batch volume	2.0 cubic feet	
Design Air Content	10% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1		9.0	7.0	5.5	AMR TABBARAH
			9.0	8.5	5.5	
			7.5	7.0	5.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	8.7%	9.6%	9.3%	

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 24 / 83	VARIABLE TESTED: AGGREGATE $S_{e}l_{f}$	BATCH NO: $S_{e}l_{f}$ 1

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 59%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.36%	95	3	Silicious	136.5	0.72
FA	2.55	3.8%	-3.53%			Limestone blend	81.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.8 lbs.	22.3 lbs.	0.45

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 3/4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	5.0	6.0		6.0	MAZEN JABRI
		5.0	6.0		5.5	
		5.0	6.0		5.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	7.6%	7.6%	7.6%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 24 / 83	VARIABLE TESTED: AGGREGATE S_c1_f	BATCH NO: S_c1_f 2

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 59%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.36%	95	3	Silicious	136.5	0.72
FA	2.55	3.8%	-3.53%			limestone blend	81.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.8 lbs.	22.3 lbs.	0.45

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	15.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5"
Strength	(28-day) 4920 psi	(28-day) >3600 psi
Batch volume	2 cubic feet	
Design Air Content	6% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1	4.0	5.0		4.5	AMR TABBARAH
		4.0	5.0		5.0	
		4.0	5.0		5.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	4.8%	4.6%	4.7%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/25/83	VARIABLE TESTED: AGGREGATE S_c1_f	BATCH NO: S_c1_f 3

AMBIENT TEMPERATURE: 74°F	RELATIVE HUMIDITY: 62%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight lbs.	Factor
CA	2.62	0.5%	-0.41%	95	3	Silicious	136.0	0.72
FA	2.55	3.81%	-3.53%		1	limestone bl.	81.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.8 lbs.	22.3 lbs.	0.45

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	18.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3"	3-5"
Strength	(28-day) 4990 psi	(28-day) >3600 psi
Batch volume	2 cubic feet	
Design Air Content	6% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	4.0	4.5		4.0	MAZEN JABRI
		4.0	4.5		4.0	
		4.0	4.5		4.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	5.0%	5.1%	5.1%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 25/ 83	VARIABLE TESTED: AGGREGATE S_c1_f	BATCH NO: S_c1_f 4

AMBIENT TEMPERATURE:	74°F	RELATIVE HUMIDITY:	62%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.41%	95	3	Silicious	136.0	0.72
FA	2.55	3.81%	-3.53%		1	limestone blend	81.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.8 lbs.	22.3 lbs.	0.45

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 1/2"	3-5"
Strength	(28-day) 3980 psi	(28-day) >3600 psi
Batch volume	2 cubic feet	
Design Air Content	6% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	6.0	6.0		7.0	AMR TABBARAH
		6.0	6.0		6.5	
		5.5	6.5		6.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP2	7.6%	7.5%	7.5%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 25 / 83	VARIABLE TESTED: AGGREGATE $L_c$sf 1	BATCH NO: $L_c$sf 1

AMBIENT TEMPERATURE: 74°F	RELATIVE HUMIDITY: 62%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.55	2.95%	-2.78%	92	2	Limestone	129.0	0.72
FA	2.59	0.8%	2.24%		1	Silicious	88.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	19.8 lbs.	21.6 lbs.	0.47

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 1/2"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	5.0	5.5		5.0	MAZEN JABRI
		5.0	5.5		5.0	
		5.0	6.0		5.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	8.3%	8.2%	8.3%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 25/ 83	VARIABLE TESTED: AGGREGATE $L_c s_f$	BATCH NO: $L_c s_f$ 2

AMBIENT TEMPERATURE: 74°F	RELATIVE HUMIDITY: 62%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight lbs.	Factor
CA	2.55	2.95 %	-2.78%	92	2	limestone bl.	129.0	0.72
FA	2.59	0.8%	+2.24%		1	Silicious	88.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	3	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	19.8 lbs.	21.6 lbs.	0.47

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	15.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 3/4"	3-5"
Strength	(28-day) 4970 psi	(28-day) >3600 psi
Batch volume	2 cubic feet	
Design Air Content	6% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	5.0	6.0		6.0	AMR TABBARAH
		5.0	5.5		5.5	
		5.0	6.0		5.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	7.6%	7.6%	7.8%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 26/ 83	VARIABLE TESTED: AGGREGATE $L_c s_f$	BATCH NO: $L_c s_f$ 3

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 52%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.55	2.95%	2.78 %	92	2	limestone bl.	129.0	0.72
FA	2.59	0.8%	2.83%		1	Silicious	86.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs.	21.4 lbs.	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	12. 0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3"	3-5"
Strength	(28-day) 5200 psi	(28-day) 3600 psi
Batch volume	2 cubic feet	
Design Air Content	6% + 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	4.0	4.0		4.0	MAZEN JABRI
		3.5	4.0		4.0	
		4.0	4.0		4.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	5.5%	5.6%	---------	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 26/ 83	VARIABLE TESTED: AGGREGATE $L_c s_f$	BATCH NO: $L_c s_f$ 4

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 52%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.55	2.95%	-2.78%	92	2	limestone bl.	129.0	0.72
FA	2.59	0.8%	2.83%		1	Silicious	86.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.6 lbs.	21.9 lbs.	0.49

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	12.0g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 1/4"	3-5"
Strength	(28-day) 5200 psi	(28-day) >3600 psi
Batch volume	2 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	4.0	5.0		4.0	AMR TABBARAH
		4.0	5.0		4.5	
		4.0	5.0		4.0	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP 2	5.2%	5.2%	5.1%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 26 / 83	VARIABLE TESTED: AGGREGATE $L_e$sf	BATCH NO: $L_e$sf 5

AMBIENT TEMPERATURE:	76°F	RELATIVE HUMIDITY:	52%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.55	2.95%	-2.78%	92	2	Limestone	129.0	0.72
FA	2.59	0.8%	2.83%		1	Silicious	86.5	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.6 lbs.	21.9 lbs.	0.49

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	13.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1 (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	4.0	5.0		4.5	MAZEN JABRI
		4.0	5.0		4.5	
		4.0	5.0		4.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	6.5%	6.5%	6.4%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 26/ 83	VARIABLE TESTED: AGGREGATE $L_c 1_f$	BATCH NO: $L_c 1_f$ 1

AMBIENT TEMPERATURE: 76°F	RELATIVE HUMIDITY: 52%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight lbs.	Factor
CA	2.55	2.95%	-2.78%	92	2	limestone bl.	129.0	0.72
FA	2.55	3.81%	-3.53%			limestone bl.	91.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	17.5 lbs.	24.6 lbs.	0.42

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	15.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 3/4"	3-5"
Strength	(28-day) 5100 psi	(28-day) ≥3600 psi
Batch volume	2 cubic feet	
Design Air Content	6% + 1% (Mixing time = 4.5 min.)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	OP1	4.5	5.0		4.5	AMR TABBARAH
		4.5	4.5		4.5	
		4.5	5.0		4.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP				
	OP_2	6.1%	6.1%	5.9%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 27 / 83	VARIABLE TESTED: AGGREGATE L_c1_f	BATCH NO: L_c1_f 2

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 55%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.55	2.95%	-2.78%	92	2	limestone bl.	129.0	0.72
FA	2.55	3.81%	-3.53%			limestone bl.	91.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.5 lbs.	25.6 lbs.	0.44

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	15.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 3/4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2 cubic feet	
Design Air Content	6% + 1% (Mixing time = 4.0 min.)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2	3.5	5.0		4.5	MAZEN JABRI
		3.5	4.5		4.0	
		3.5	4.5		4.0	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP 1	6.3%	6.2%	6.2%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5 / 27 / 83	VARIABLE TESTED: AGGREGATE L_{cf} 1	BATCH NO: L_{cf} 1 3
AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 55%	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.55	2.95%	-2.78%	92	2	limestone bl.	129.0	0.72
FA	2.55	3.81%	-3.53%			limestone bl.	91.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.5 lbs.	25.6 lbs.	0.44

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	15.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5"
Strength	(28-day) 4470 psi	(28-day) ≥ 3600 psi
Batch volume	2 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	$\bar{C5}$	C2	C3	C4	
CHACE AIR INDICATOR	OP1	4.5	4.5		4.5	AMR TABBARAH
		4.0	5.0		4.5	
		4.5	5.0		4.5	
	OP2					MAZEN JABRI
	OP3					

PRESS-URE METER	PM	P1	P2	P3	
	OP				
	OP_2	6.5%	6.5%	6.4%	Mazen Jabri

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 5/ 27 / 83	VARIABLE TESTED: ACCREGATE $L_c 1_f$ 4	BATCH NO: $L_c 1_f$ 4

AMBIENT TEMPERATURE: 75°F	RELATIVE HUMIDITY: 55%

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.55	2.95%	-2.78%	92	2	Limestone	129.0	0.72
FA	2.55	3.81%	-3.53%			Limestone	91.0	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs.	6

WATER	Design weight	Net Weight (after correction)	w/c
	18.5 lbs.	25.6 lbs.	0.44

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	15.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cubic feet	
Design Air Content	6% ± 1% (Mixing time = 3.0 min.)	

MEASURED AIR CONTENT	CAI	C1	C2	C3	C4	
CHACE AIR INDICATOR	OP1					AMR TABBARAH
	OP2		4.5		4.0	MAZEN JABRI
			4.0		3.5	
			4.0		3.5	
	OP3					

PRESS-UR METER	PM	P1	P2	P3	
	OP_1	6.3%	6.4%	6.2%	Amr Tabbarah
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 7/28/83	VARIABLE TESTED: Low Air	BATCH NO: 1

AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136.0	0.72
FA	2.59	0.8%	-0.8%		1	Silicious	91.0	

CEMENT	Brand	Type	Weight	Factor
	Alamo	I	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs	21.5 lbs	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	6g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2 cu ft	
Design Air Content	3% ± 1 (Mixing time = 3 min)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	Tapping and Shaking		3.5			AMR TABBARAH
			4.0			
			4.0			
	Tapping		4.0			
			3.5			
			3.5			

PRESS-UR METER	PM	P1	P1	P1	
	OP	4.3%	4.1%	3.8%	
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 7/28/83	VARIABLE TESTED: Low Air	BATCH NO: 2
AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136.0	0.72
FA	2.59	0.8%	-0.8%		1	Silicious	91.0	

CEMENT	Brand	Type	Weight	Factor
	Alamo	I	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs	21.5 lbs	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	6g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 1/2"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2 cu ft	
Design Air Content	3% ± 1 (Mixing time = 3 min)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	Tapping and Shaking				4.5	AMR TABBARAH
					4.0	
					4.5	
	Tapping				4.5	
					4.0	
					4.0	
PRESS-UR METER	PM	P2	P2	P2		
	OP	4.4	4.1	4.0		
	OP					

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 7/28/83	VARIABLE TESTED: Low Air	BATCH NO: 3
AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%		95	3	Silicious	136.0	0.72
FA	2.59	0.8%			1	Silicious	91.0	

CEMENT	Brand	Type	Weight	Factor
	Alamo	I	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs	21.5 lbs	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	6 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	5"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2 cu ft	
Design Air Content	3% ± 1 (Mixing time = 3 min)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR		3.5				AMR TABBARAH
		4.0				
		3.5				
		4.0				
		3.5				
		3.5				
PRESS-UR METER	PM	P3	P3	P 3		
	OP	3.7%	3.7%	3.4%		
	OP					

PROJECT 3-9-83-363

EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 7/30/83	VARIABLE TESTED: Medium Air	BATCH NO: 1

AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136	0.72
FA	2.59	0.8%	-0.2%		1	Silicious	82	

CEMENT	Brand	Type	Weight	Factor
	Alamo	8	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs	20.9 lbs	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	15 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 3/4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cu ft	
Design Air Content	6% ± 1% (Mixing Time = min)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	Tapping and Shaking		5.5			AMR TABBARAH
			6.0			
			6.5			
	Tapping		5.0			
			5.0			
			5.0			

PRESS-UR METER	PM	P1	P1	P1	
	OP2	5.3	5.6	5.1	
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 7/29/83	VARIABLE TESTED: Medium Air	BATCH NO: 2
AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136	0.72
FA	2.59	0.8%	-0.2%		1	Silicious	82	

CEMENT	Brand	Type	Weight	Factor
	Alamo	I	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs	20.9 lbs	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	15.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	3 1/2"	3-5%
Strength	(28-day)	(28-day)
Batch volume	2.0 cu ft	
Design Air Content	6% ± 1% (Mixing Time = 3.0 min)	

MEASURED AIR CONTENT	CAI	C 5	C2	C3	C4	
CHACE AIR INDICATOR	Tapping and Shaking				6.0	
					6.0	AMR TABBARAH
					5.5	
	Tapping				5.5	
					5.5	
					5.5	

PRESS-UR METER	PM	P 2	P 2	P 2	
	OP	5.5	5.7	5.3	
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 7/29/83	VARIABLE TESTED: Medium Air	BATCH NO: 3

AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136	0.72
FA	2.59	0.8%	-0.2%		1	Silicious	82	

CEMENT	Brand	Type	Weight	Factor
	Alamo	I	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs	20.9 lbs	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	15.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 1/2"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cu ft	
Design Air Content	6% ± 1% (Mixing Time = 3.0 min)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	Tapping and Shaking	6.0				AMR TABBARAH
		6.0				
		5.5				
	Tapping	5.5				
		5.5				
		5.5				

PRESS-UR METER	PM	P3	P3	P3	
	OP	6.5%	6.2%	5.9%	
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 7/29/83	VARIABLE TESTED: High Air	BATCH NO: 1

AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136	0.72
FA	2.59	0.8%	-0.2%		1	Silicious	82	

CEMENT	Brand	Type	Weight	Factor
	ALAMO	I	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.0 lbs	20.9 lbs	0.48

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	20.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	6 1/2	3-5"
Strength	(28-day)	(28-day)
Batch volume	2 cu ft	
Design Air Content	6% $\pm$ 1% (Mixing Time = 3.0 min)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	Tapping and Shaking		8.0			AMR TABBARAH
			9.0			
			8.5			
	Tapping		8.0			
			7.5			
			8.0			

PRESS-UR METER	PM	P1	P1	P1	
	OP	8.5	8.8	8.5	
	OP				

PROJECT 3-9-83-363
EVALUATION OF CHACE AIR INDICATOR FOR USE IN CONCRETE CONSTRUCTION

DATE: 7/30/83	VARIABLE TESTED: High Air	BATCH NO: 2
AMBIENT TEMPERATURE:	RELATIVE HUMIDITY:	

	Specific Gravity	Absorption Capacity	Free Moisture	Unit Weight	Grade	Type	Weight	Factor
CA	2.62	0.5%	-0.5%	95	3	Silicious	136	0.72
FA	2.59	0.8%	-0.2%		1	Silicious	65	

CEMENT	Brand	Type	Weight	Factor
	Alamo	I	42.0 lbs	6

WATER	Design weight	Net Weight (after correction)	w/c
	20.1 lbs	20.9 lbs	0.48 lbs

ADMIXTURE TYPE	Quantity	Brand
Air Entrainer	40.0 g	SEPTAIR
Water Reducer (type A)		
High Range Water Reducer		

CONCRETE	Measured value	Design value
Slump	4 1/4"	3-5"
Strength	(28-day)	(28-day)
Batch volume	2.0 cu ft	
Design Air Content	10% ± 1% (Mixing Time = min)	

MEASURED AIR CONTENT	CAI	C5	C2	C3	C4	
CHACE AIR INDICATOR	Tapping and Shaking				9.0	AMR TABBARAH
					9.5	
					8.5	
	Tapping				8.0	
					8.5	
					7.5	

PRESS-UR METER	PM	P 2	P 2	P 2	
	OP	9.0	8.6	8.3	
	OP				

APPENDIX B

INSTRUMENT AND MATERIAL PROPERTIES

APPENDIX B

INSTRUMENT AND MATERIAL PROPERTIES

B.1 Instrument Properties

B.1.1 CAI

All Chace Air Indicators (soil test CT -158, concrete air indicator) were found to have a Chace Factor of 2.5.

B.1.2 All pressure meters were Soil Test CT-125, Press-Ur meter.

B.2 Material Properties

B.2.1 Aggregates

B.2.1.1 Fine Aggregates (Sand)

(1) Grade 1 requirements satisfied
(2) Fineness modulus = 2.53
(3) Saturated-surface-dry specific gravity = 2.59
(4) Absorption capacity = 0.8%

B.2.1.2 Coarse Aggregates (Gravel)

(1) Saturated-surface-dry weight = 95.0 lb/ft^3
(2) Saturated-surface-dry specific gravity = 2.62
(3) Absorption capacity = 0.5%

B.2.2 Air Entraining Agent, Admixture and Cements

B.2.2.1 Air Entraining Agent

It is a vinsol resin of SEPTAIR brand manufactured by Monier Resources, Inc.

B.2.2.2 Admixtures

(1) Water Reducer: Pozzolith 322N brand manufactured by Master Builders.

(2) High Range Water Reducer: Pozzolith 400N brand manufactured by Master Builders.

B.2.2.3 Cements

(1) Cement type I: of Alamo brand

(2) Cement type II: of Centex brand

(3) Cement type III: of Alamo brand

APPENDIX C

REGRESSION ANALYSIS

Table C.1. Sample of Regression Analysis Calculations for Average of Three CAI Readings for Variable HS.

Xmc (%)	PMR (%)	Y1 (%)	(PMR-Y1) (%)	d (%)	(d+Y1) (%)
7.2	5.3	6.1	-0.8	0.0	6.1
7.5	5.3	6.4	-1.1	0.0	6.4
7.7	5.3	6.6	-1.3	0.0	6.6
7.3	6.0	6.2	-0.2	0.0	6.2
7.6	6.0	6.5	-0.5	0.0	6.5
7.6	6.0	6.5	-0.5	0.0	6.5
8.0	6.0	6.8	-0.8	0.0	6.8
8.0	6.0	6.8	-0.8	0.0	6.8
8.3	6.0	7.1	-1.1	0.0	7.1
7.7	5.6	6.6	-1.0	0.0	6.6
7.3	5.6	6.2	-0.6	0.0	6.2
7.3	5.6	6.2	-0.6	0.0	6.2
7.2	5.5	6.1	-0.6	0.0	6.1
7.2	5.5	6.1	-0.6	0.0	6.1
7.5	5.5	6.4	-0.9	0.0	6.4

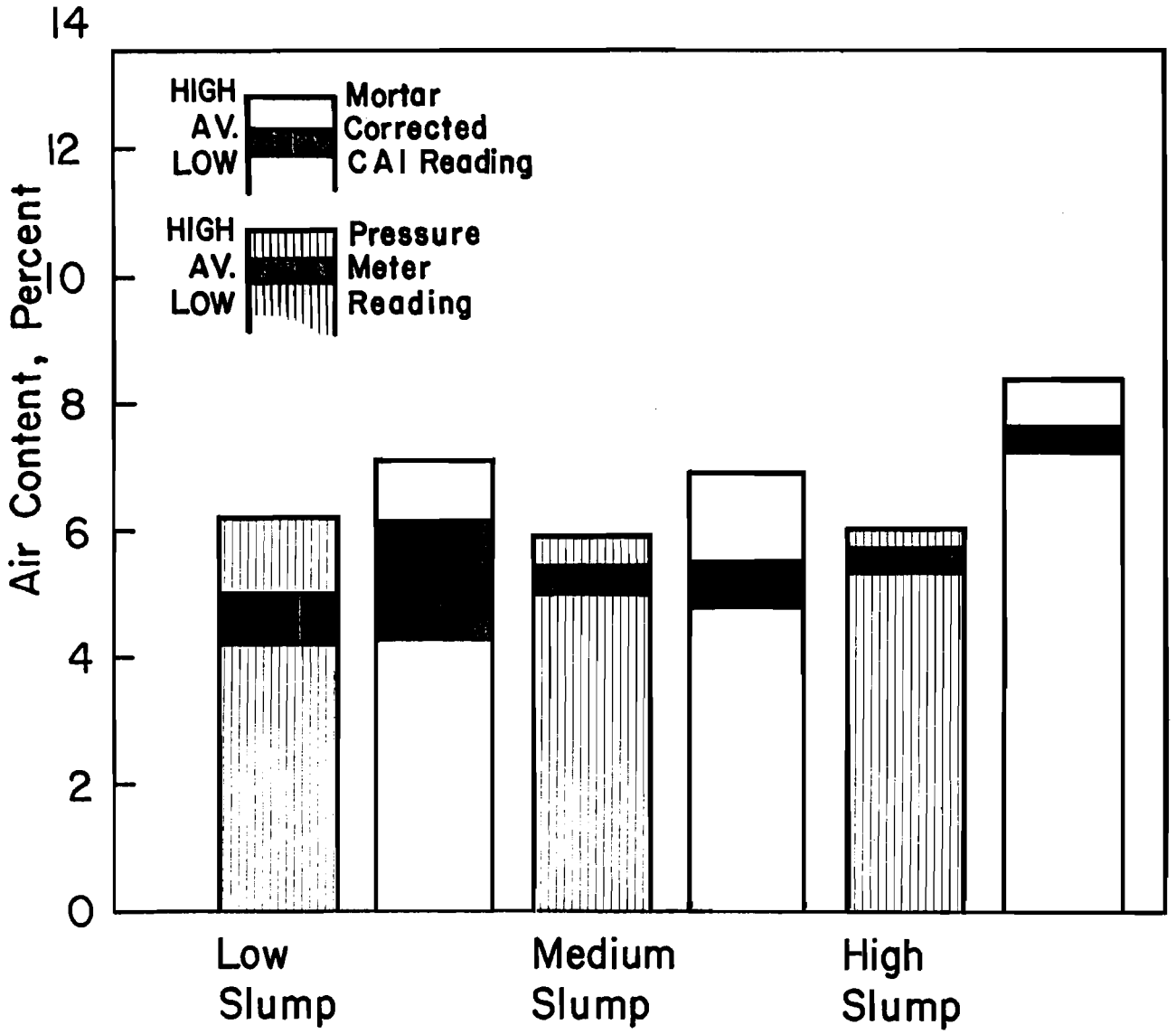

Fig. C.1 Comparison of Xmc and PMR

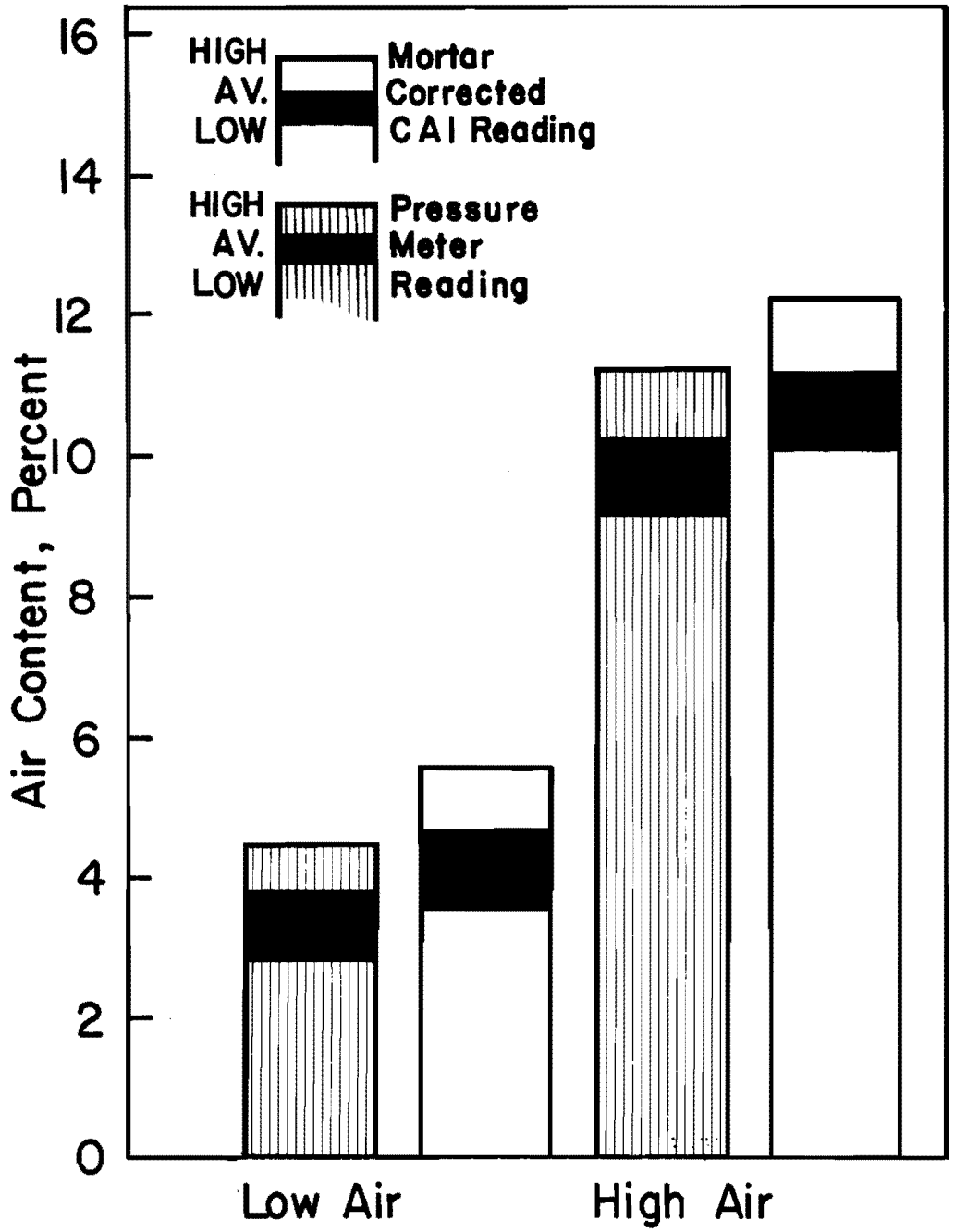

Fig. C.1 (Continued)

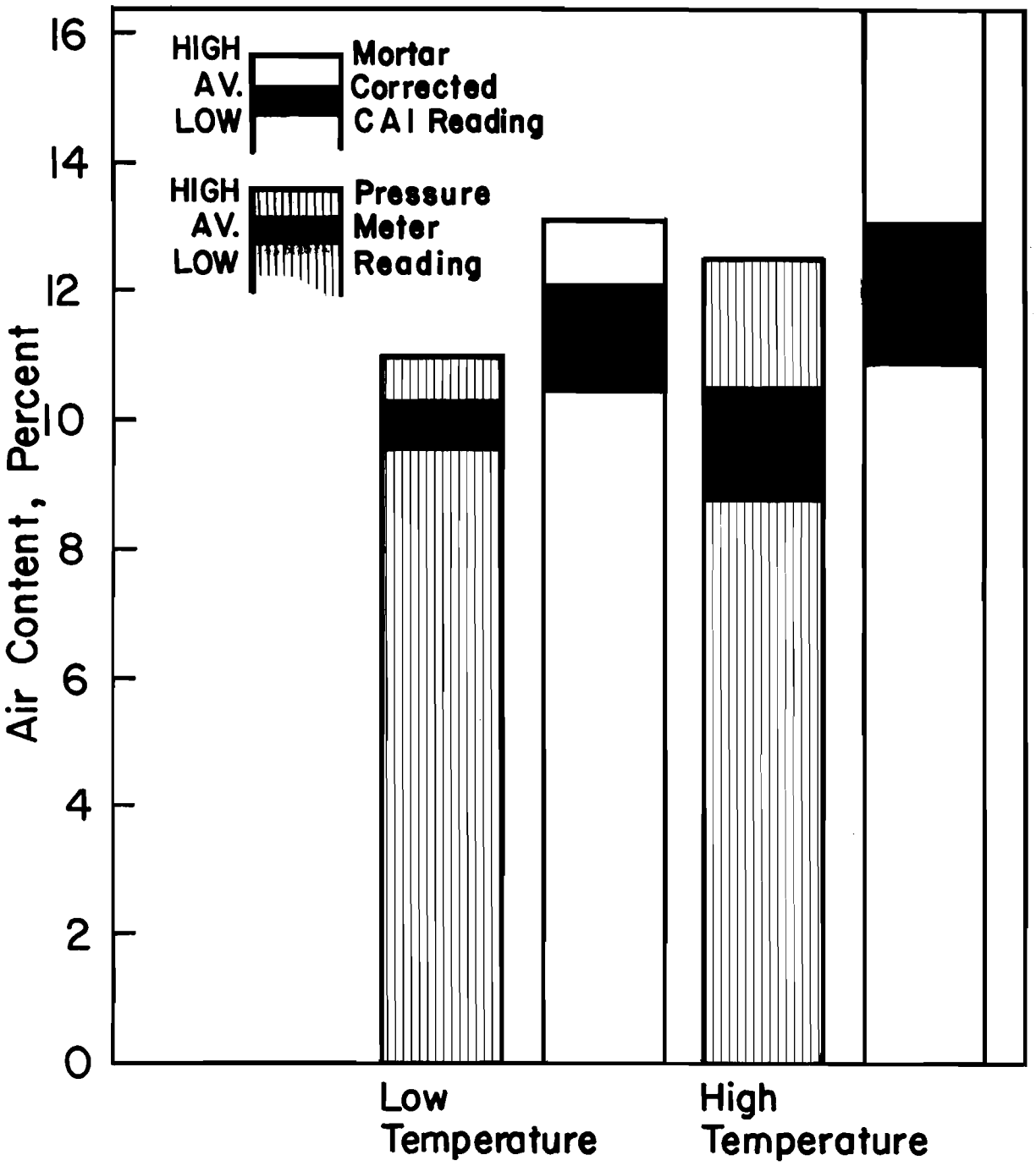

Fig. C.1 (Continued)

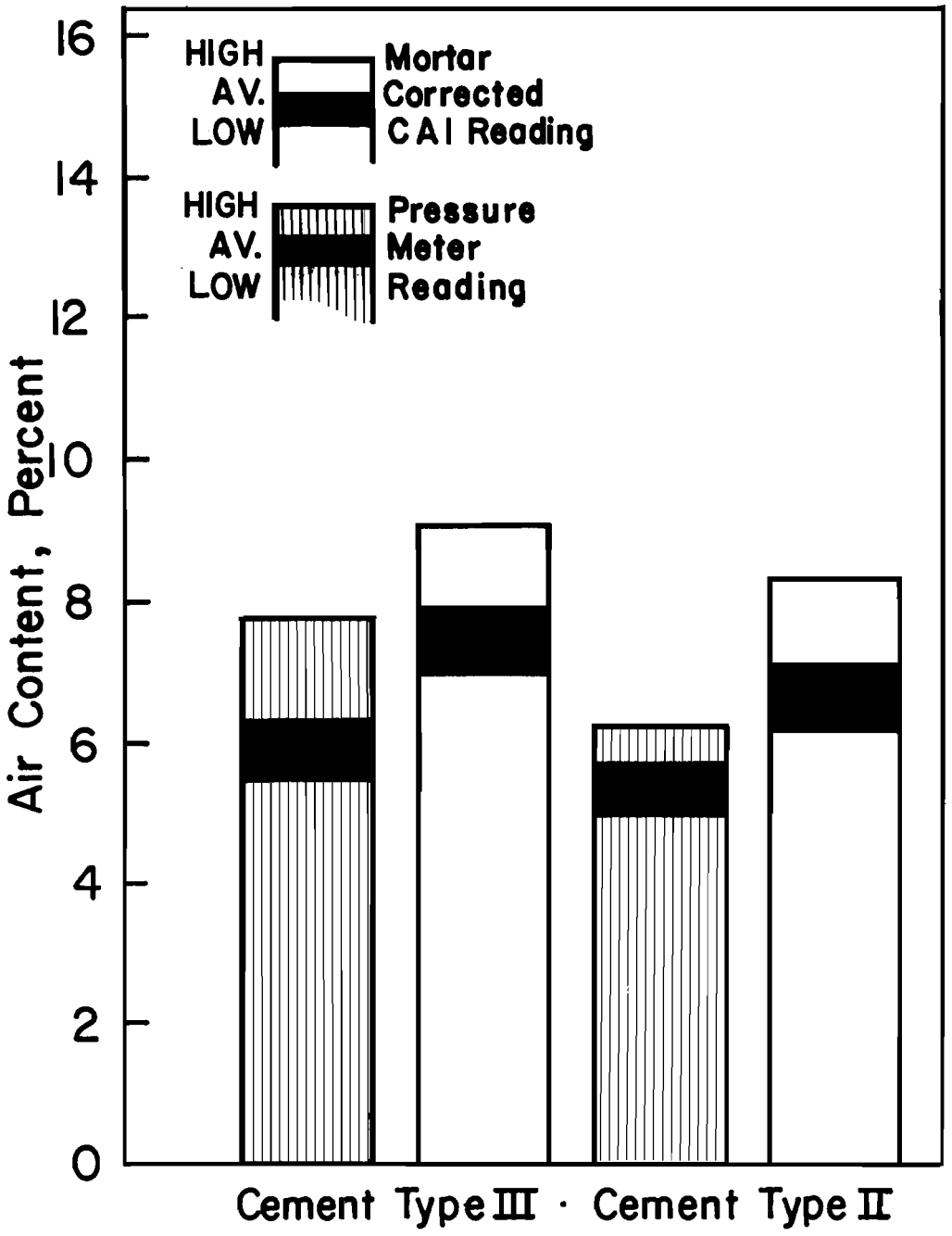

Fig. C.1 (Continued)

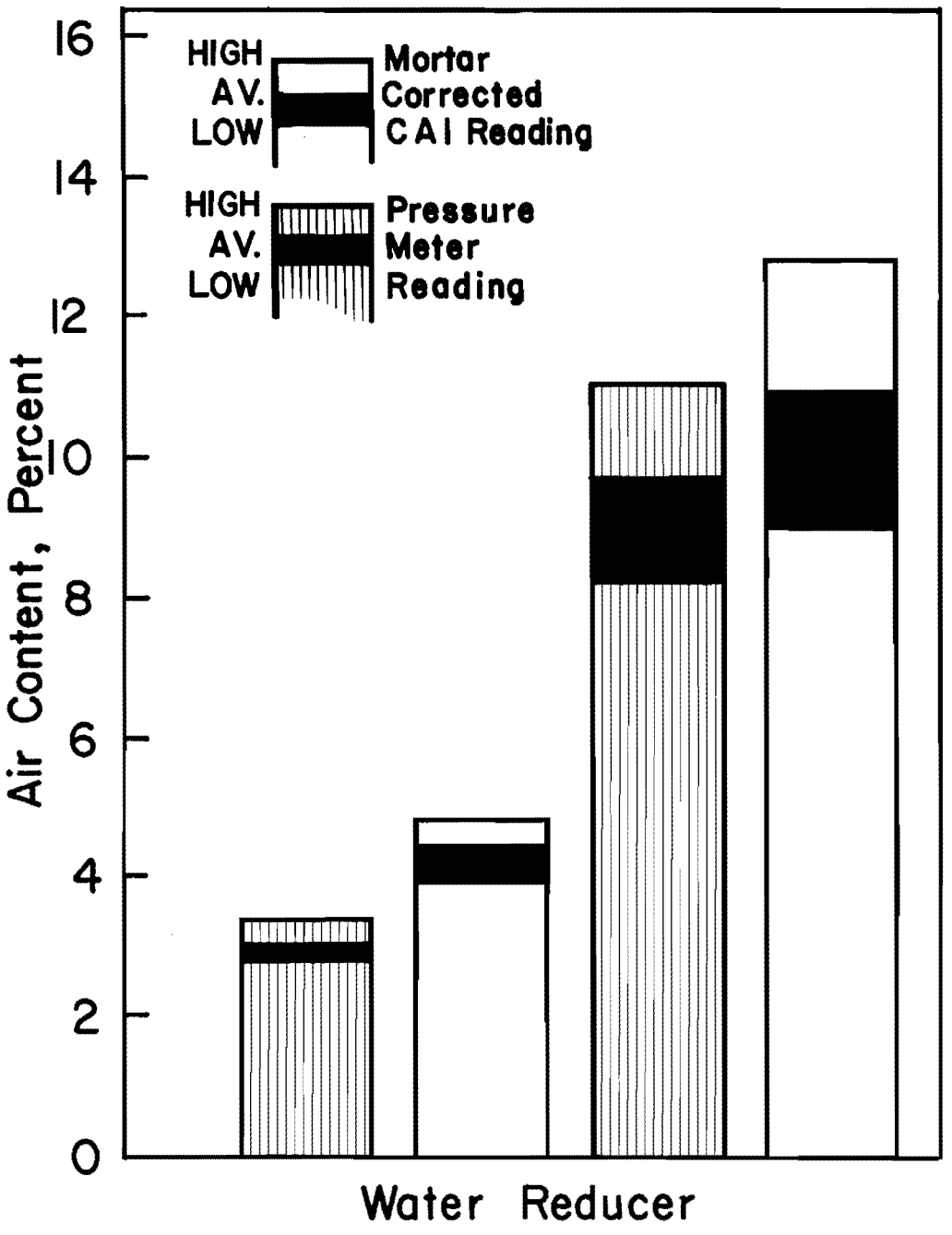

Fig. C.1 (Continued)

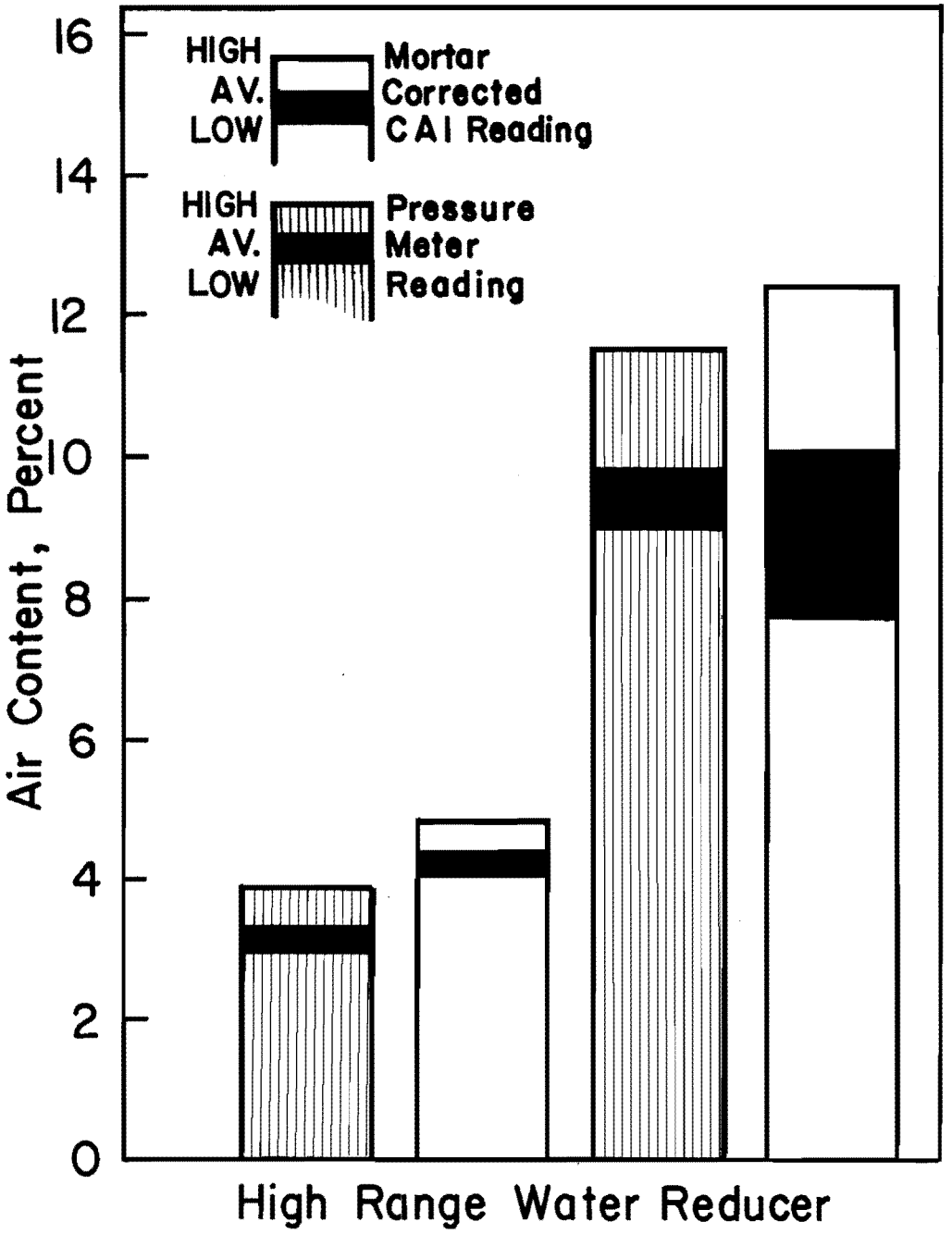

Fig. C.1 (Continued)

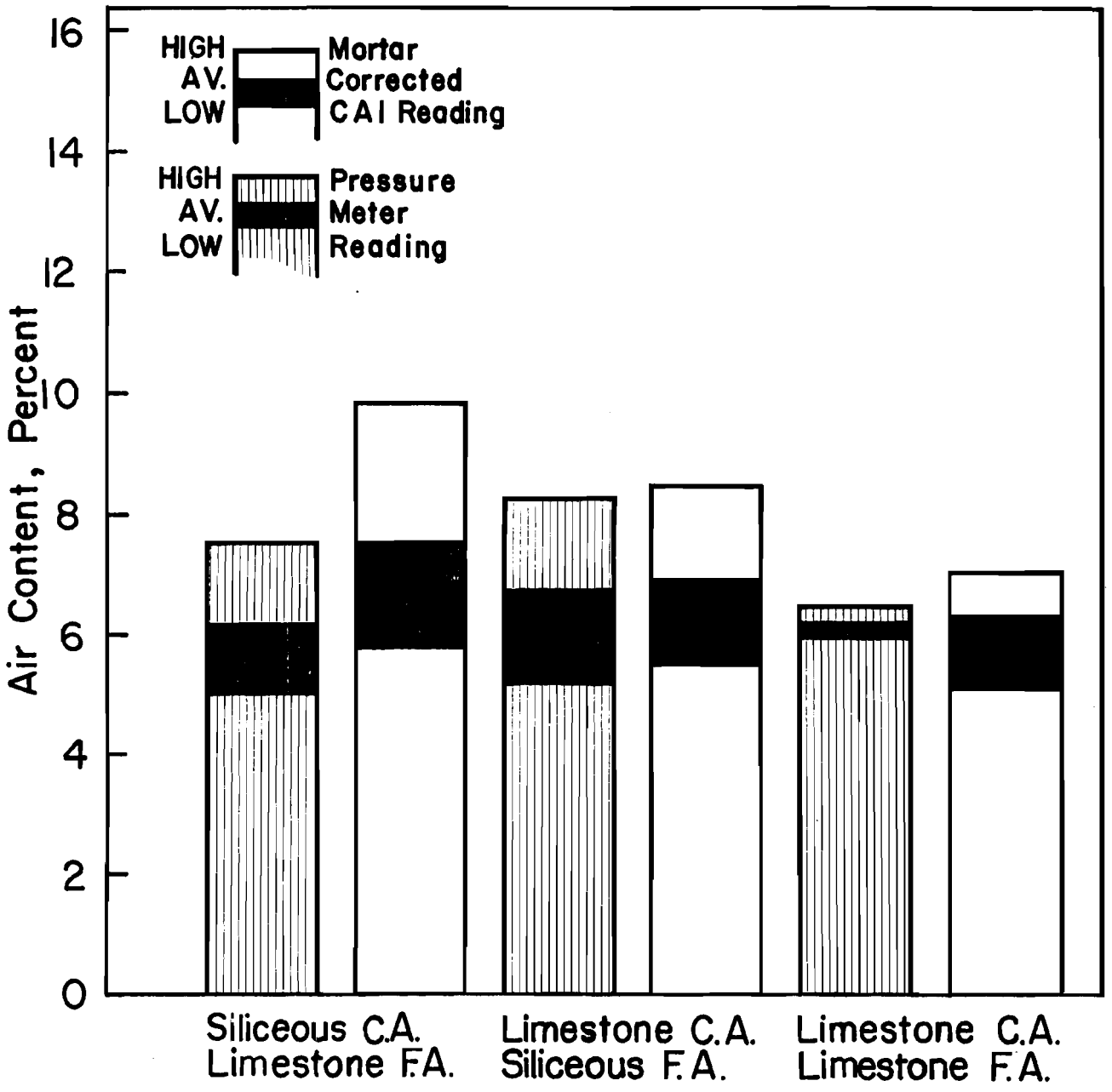

Fig. C.1 (Continued)

APPENDIX D

DERIVATION OF EQUATION 5.2

APPENDIX D

DERIVATION OF EQUATION 5.2

The total volume of concrete can be divided in two parts. First, the volume of air, and second, the volume of solids, including water.

Letting

V = designed volume of concrete

v = actual volume of concrete

P = designed air content in concrete

p = actual air content in concrete

VS = volume of solids in designed volume of concrete

vs = volume of solids in actual volume of concrete

then $$VS = (V)(1 - P), \text{ and} \tag{D.1}$$

$$vs = (v)(1 - p) \tag{D.2}$$

But the volume of solids does not change, and hence

Vs = vs, and

$$\frac{V}{v} = \frac{(1 - p)}{(1 - p)} \tag{D.3}$$

The absolute volume of the coarse aggregates (CAV) is given by

$$CAV = \frac{(CAF)(UW)(V)}{(\text{specific weight of water})(G)} \tag{D.4}$$

where CAF = coarse aggregate factor

UW = saturated surface dry unit weight of the coarse aggregaates in use, expressed in lb/cu ft

G = saturated surface dry specific gravity of the coarse aggregates in use.

The actual mortar volume (MV) is given by

$$MV = v - CAV$$

$$MV = v - \frac{(CAF)(UW)V}{(62.4)(G)} \tag{D.5}$$

The actual mortar content, expressed as a decimal fraction, is given by

$$MC = \frac{MV}{v}$$

$$= 1 - \frac{(CAF)(UW)V}{(624)(G)v} \tag{D.6}$$

Replacing $\frac{V}{v}$ by equation D.3 yields

$$MC = 1 - \frac{(CAF)(UW)(1 - p)}{(624)(G)(1 - p)} \tag{D.7}$$

Expressing MC in terms of cu ft/cu yd, equation D.7 becomes

$$MC = 27 - \frac{(27)(CAF)(UW)(1 - p)}{(62.4)(G)(1 - P)} \tag{D.8}$$

APPENDIX E

RECOMMENDED PROCEDURE FOR THE USE OF THE CAI

APPENDIX E

RECOMMENDED PROCEDURE FOR THE USE OF THE CAI

The test could consist of one reading, or the average of two or three readings. Before starting the test, the Chace Factor should be found, and the best approximation for the mortar content of the concrete determined.

Procedure:

(1) Start with clean and dry indicator, stopper, and cup (Fig. 4.1).

(2) Fill the brass cup with cement mortar from the concrete to be tested, excluding particles of sand larger than 1/12 in. (2.0 mm). A narrow knife blade or spatula is most suitable for picking up the mortar (Fig. 4.1).

(3) Rod the mortar in the cup uniformly, about 20 times, using a thin, stiff wire (the wire in a No. 1 Gem paper clip is suitable) (Fig. 4.2). If large sand particles are detected during rodding, they should be removed.

(4) Tap on the sides of the cup using the handle of the knife or the spatula to allow large air pockets to escape (Fig. 4.3).

(5) Strike off the mortar flush with the top of the cup while applying a gentle sawing motion with the blade of the spatula on the top of the cup. Hold the blade perpendicular to the top of the cup.

(6) Clean the sides of the cup and stopper with a paper towel Fig. (4.4).

(7) Invert the indicator, close the smaller end of the indicator with the forefinger and hold the stem between the thumb and the middle finger (Fig. 4.5).

(8) Fill the tube with alcohol to the reference line.

(9) Insert the stopper into the tube.

(10) Invert the indicator, push the stopper farther into the tube irrespective of the level of the alcohol inside the stem (Fig. 4.6) until the stopper is in a fixed and tight position.

(11) Put the indicator on a levelled surface.

(12) Bring the level of the alcohol to the upper mark of the stem either by adding more alcohol with the medicine dropper or by removing the excess alcohol through the use of a tapered paper towel (Fig. 4.7). The level of the alcohol is adequate if the bottom of the meniscus coincides with the upper mark of the stem. Be sure that no air bubbles are in the stem of the indicator.

(13) Wet the forefinger that will close the opening of the stem with water (Fig. 4.8).

(14) Close the opening of the stem with the wet finger. The indicator should be held with both hands. The forefinger and thumb of one hand are used to close the open end of the stem, while the same fingers of the other hand are used to hold the top from the larger end.

(15) To empty the mortar from the cup, invert the indicator and shake it laterally until all the mortar drops into the alcohol (Fig. 4.9), then invert the indicator again. Shaking consists of short lateral vibratory movements.

(16) Roll the indicator from vertical to horizontal position, while continuing the lateral shaking until all the mortar is dispersed in the alcohol. To determine that all the mortar is dispersed, stop the rolling and hold the indicator vertically without removing the forefinger from the stem opening, wait for the alcohol to drop down and for the large air bubbles to go up, and take an approximate reading. Repeat the rolling and shaking several times and take a new reading; if the two readings are similar then all the mortar is dispersed, if not, repeat the rolling, shaking, and reading, until two consecutive readings are the same.

(17) Put the indicator on a levelled surface, wait for the alcohol to drop down and for the large air bubbles to go up.

(18) Remove the forefinger closing the stem and take the reading to the nearest half graduation (Fig. 4.10).

Steps 1 through 18 show how one reading could be obtained. To obtain a second and third reading, steps 1 through 18 should be repeated.

Denote the single reading or average of two or three readings by Xu, the Chace Factor by CF, and the Mortar Content expressed in cu ft/cu yd by Mc. The mortar corrected reading Xmc can be determined by

$$Xmc = \frac{(CF)(MC)}{27} (Xu) \qquad (C.1)$$

and the air content (Y) can be determined by

$$Y = (0.842)Xmc + 0.064 \qquad (C.2)$$

The value of Y should have one decimal figure only.

If one reading was taken, then the actual air content is between (Y - 1.6 percent) and (Y + 1.6 percent).

If two readings were taken, then the actual air content is between (Y - 1.2 percent) and (Y + 1.2 percent)

If three readings were taken, then the actual air content is between (Y - 0.9 percent) and (Y + 0.9 percent).

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