IOWA STATE HIGHWAY COMMISSION
MATERIALS DEPARTMENT
CENTRAL LABORATORY

FINAL REPORT
R-269

EVALUATION OF THE ARGENTINE NONDESTRUCTIVE TEST FOR DETERMINING CONCRETE COMPRESSIVE STRENGTH

FEBRUARY 1975

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Special Investigations Section

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February, 1975

Materials Laboratory

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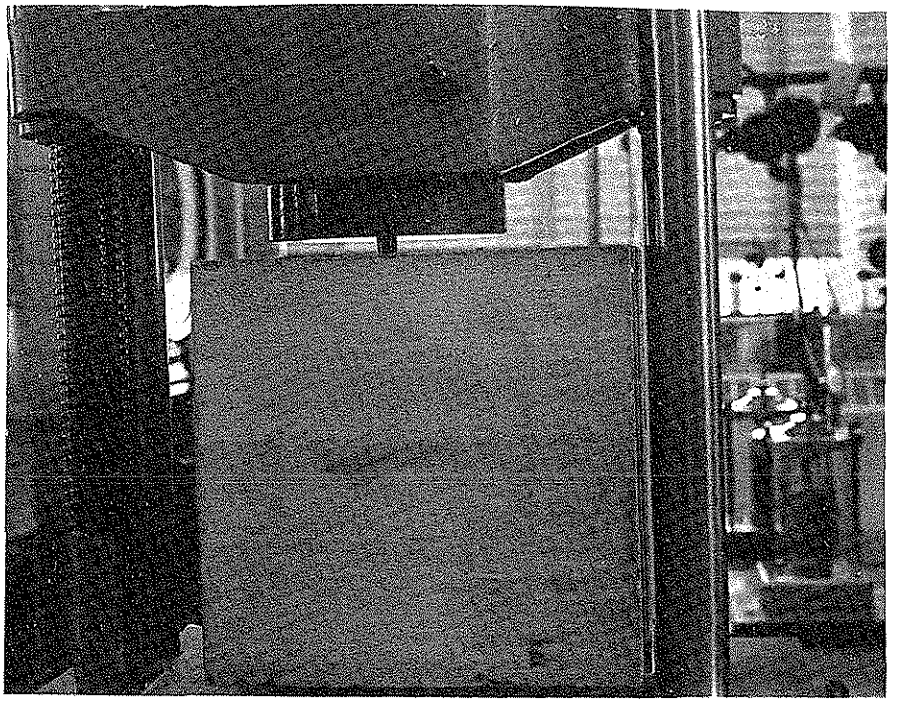
1.0 INTRODUCTION

The compressive strength of concrete is an important factor in the design of concrete structures and pavements. To assure the quality of the concrete placed at the project, concrete compressive cylinders are made at the jobsite. These cylinders undergo a destructive test to determine their compressive strength.

However, the determination of concrete compressive strength of the concrete actually in the structure or pavement is frequently desirable. For this reason, a nondestructive test of the concrete is required. A nondestructive test of concrete compressive strength should be economical, easily performed by field personnel, and capable of producing accurate, reproducible results. The nondestructive test should be capable of detecting the extent of poor concrete in a pavement or structure due to improper handling, placement, or variations in mixing or materials.

Previous tests which have been developed to nondestructively test concrete have been based on ultrasonic frequencies and rebound hammers. The March 1974 issue of the Journal of the American Concrete Institute, No. 3, Proceedings Volume 71 contains a Materials

Feature on the Argentine Nondestructive Test for Determining Compressive Strength written by Cesar J. Luisoni and Hector M. Somenson on pages 132 and 133. The test involved applying a high compressive force to a small area of concrete.



A High Compressive Force
Applied to a Small
Area of Concrete

The small area of concrete in the Argentine test had the load applied through a hardened steel pin with a diameter of 0.591 inches and an area of 0.274 square inches. The pin was loaded with a force in the order of 24,000 lbs. A shallow fracture about 1/8 inch deep results due to the shearing forces.

Shallow Fracture due
to High Shearing Forces

The compressive strength to cause this fracture was correlated with the compressive strengths on cylinders made from the same concrete.(1) In the Argentine testing several different cylinders were made with water/cement ratios of 0.40, 0.50, 0.60, 0.70, and 1.00 to vary the compressive strengths. Three 1 cubic foot blocks for pin loadings and five 6 inch diameter by 12 inch length cylinders for compressive loads were made at each w/c ratio. Two w/c ratio series of blocks and cylinders were made; one series used a fine sand for the aggregate and the other series used a crushed stone. Actual field measurements would be correlated to

(1) "Argentine Nondestructive Test for Determining Compressive Strength", Journal of the American Concrete Institute, No. 3, Proceedings Volume 71, pages 132 and 133.

these various cylinder strengths to determine the compressive strength of the concrete.

2.0 PURPOSE

The purpose of the R-269 investigation is to evaluate the Argentine Nondestructive Test for Determining Concrete Compressive Strength.

3.0 MATERIALS

The cement was a blend of Type I (R-11 blend) from seven different companies that produce for Iowa construction (Lab. No. AC2-95 and AC4-407).

The fine aggregate was from Hallett's Ames Pit and complied with Section 4110 of the Standard Specifications of the Iowa State Highway Commission (AAS4-10 and AAS4-514).

The coarse aggregate for concrete was from Hallett's Ames Pit and complied with Section 4115 of the Standard Specifications of the Iowa State Highway Commission.

The air agent was Ad-Aire produced by Carter Waters of Kansas City, Missouri.

The reinforcing wire mesh was secured from the Metals Section of the Materials Laboratory, Iowa State Highway Commission. The wire mesh conformed to ASTM A82 and A185. The mesh used was a No. 3 wire with 2" by 6" openings.

4.0 LABORATORY PROCEDURE
4.1 Testing

To evaluate the Argentine method, the Special Investigations Section of the Materials Department performed testing quite similar to the Argentine method. A one cubic foot wooden box was fabricated as a mold. A wire mesh cage was built as reinforcement to prevent the destruction of the entire cube under load.

One Cubic Foot Wooden Mold
With Reinforcing Cage

A one cubic foot block and 3 comparative horizontally cast 6 inch diameter by 12 inch length cylinders were made from each of the five mixes. The five mixes were designed to have different compressive strength. Each of the six sides of each block was loaded until the shallow fracture occurred. All tests were conducted after a 28 day moist cure.

A Typical Fracture After Loading

4.2 Tabulation of Results

The following table shows the results of the five mixes. Compressive forces (lbs.) were determined on each side of the one cubic foot cubes and compressive strengths (PSI) were determined from the compressive cylinders.

TABLE OF RESULTS

Mix No.	1	2	3	4	5
Mix Type	C-4 w/c=.400	C-4 w/c=.500	A-4	B-4	D-57
Date Made	5-14-74	6-4-74	6-19-74	6-24-74	9-13-74
Cube Side 1	29,000	*	20,400	22,150	20,950
Cube Side 2	29,400	25,200	20,900	24,850	17,500
Cube Side 3	22,800	15,500	18,200	23,250	**
Cube Side 4	20,300	19,100	18,350	16,250	15,300
Cube Side 5	24,800	23,010	19,200	21,450	25,400
Cube Side 6	22,900	23,050	19,000	25,250	24,800
Average (lbs.)	24,870	21,170	19,340	22,200	20,790
Std. Dev. (lbs.)	3,650	3,860	1,090	3,270	4,420

*Invalid test -- small spall but no load loss
**Invalid test -- reinforcement next to surface

Cylinder 1	5550	4030	4600	4310	5450
Cylinder 2	5590	4210	4280	4350	5380
Cylinder 3	5340	4140	4350	4310	5380
Average (PSI)	5490	4125	4410	4325	5400
Std. Dev. (PSI)	135	90	170	25	40
Air Content (%)	7.1	6.0	7.0	6.4	6.2
Slump (in.)	3	9-1/2	2	2-1/4	2-1/2

5.0 INTERPRETATION OF RESULTS

A study of the Table of Results in the previous section shows a high, variable standard deviation of the test cube side strengths. On the same cube, the shallow fracture would occur at widely varying load differences. As an example, on Mix No. 4 (B-4) the lowest fracture loading was 16,250 lbs. and the highest fracture loading was 25,250 lbs. This poor repeatability was evident in all 5 mixes.

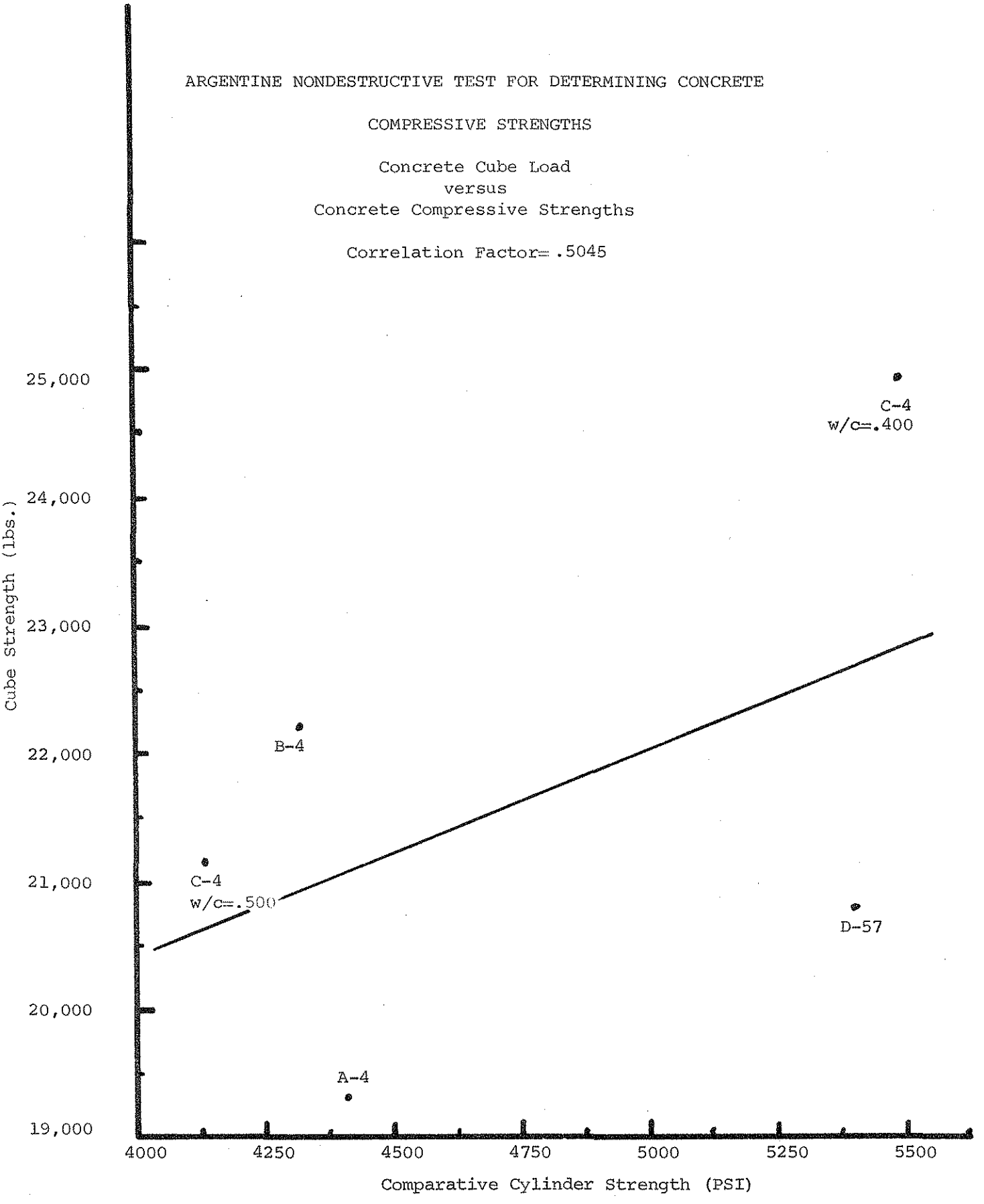
The graph on the following page shows relatively no correlation, .5045, between the average cube strength (lbs.) and the corresponding cylinder compressive strengths (PSI). Therefore, the accuracy of any field measurements would be questionable.

ARGENTINE NONDESTRUCTIVE TEST FOR DETERMINING CONCRETE

COMPRESSIVE STRENGTHS

Concrete Cube Load
versus
Concrete Compressive Strengths

Correlation Factor= .5045



The three cylinder compressive strengths from each mix had little variation. The highest standard deviation was 170 PSI for Mix No. 3. It should be noted that the C-4 mix was mixed twice, once at a .400 water/cement ratio and once at a .500 w/c ratio to vary the compressive strengths.

When considering the application of this test method to concrete pavement strength determinations it should be noted that the Iowa State Highway Commission currently is required to core samples for pavement depth measurements. These cores are also subjected to concrete compressive strength and air void tests in the Materials Laboratory.[2] For this reason a nondestructive compression test is unnecessary on portland cement concrete pavement.

6.0 SUMMARY

From the results of this study, a conclusion can be drawn that the Argentine Nondestructive Test for Determining Concrete Compressive Strength is an inaccurate, unrepeatable test. The low correlation factor exhibited in a testing laboratory would exceed the testing accuracy capable under field conditions. Also the problem of load application in a field situation would hinder testing accuracy.

For the above reasons, the Argentine Nondestructive Test for Determining Concrete Compressive Strengths should not be adopted for use by the Iowa State Highway Commission.

(2) Standard Specifications, Series of 1972, Iowa State Highway Commission, Section 2301.39, pages 223 to 226.

7.0 REFERENCES

1. "Argentine Nondestructive Test for Determining Compressive Strength", Journal of the American Concrete Institute, No. 3, Proceedings Volume 71, pages 132 and 133.

2. Standard Specifications, Series of 1972, Iowa State Highway Commission, Section 2301.39, pages 223 to 226.