EVALUATION AND USE OF THE MATERIALS AND TEST (MATT) DATA SYSTEM FOR QUALITY OF CONSTRUCTION AND MANAGEMENT REVIEW

FINAL REPORT

By

WALTER G. CARPENTER, JR.
RESEARCH ENGNEER-IN-TRAINING

And

S. C. SHAH
RESEARCH & DEVELOPMENT ENGINEER

Research Report No. 187

Research Project No. 83-1D(B)

Conducted by
LOUISIANA DEPARTMENT OF TRANSPORTATION
AND DEVELOPMENT
Louisiana Transportation Research Center
In Cooperation With
U. S. Department of Transportation
FEDERAL HIGHWAY ADMINISTRATION

December 1985

ACKNOWLEDGMENT

The authors want to acknowledge the assistance of Mr. C. N. West, Acting District 58 Laboratory Engineer.

TABLE OF CONTENTS

ABSTRACT

This report documents the review of the MATerials and Test (MATT) Data System to check the validity of data within the system. A computer program to generate the quality level of a construction material was developed. Programs were also developed to generate "action reports" for key construction materials.

IMPLEMENTATION

The implementation was an ongoing effort during the study period. Reports are being generated on a routine basis and as requested. The MATT System has undergone revisions for some of the major systems. These revisions were the result of the findings of Phase 1.

INTRODUCTION

As a part of a quality assurance program within the State of Louisiana, the Louisiana Department of Transportation and Development (LDOTD) is required to sample and test many construction materials. The results of this sampling and testing is recorded and entered in the MATerials and Test (MATT) Data System. The test results are then checked, via a night batch job, against previously entered materials specifications. After overnight processing, the data is stored in computer files for future reference and use. The entire process is repeated each working day and hundreds of new test records are generated and stored by each batch job. The MATT System has been in operation since midyear of 1978, and thousands of records have been processed and stored since its installation. This report relates a study to:

1. Check the validity and integrity of previously processed MATT System records.

2. Use the stored MATT System data to create and test a program that will generate the FHWA's Quality Index (1)* a material.

3. Use the stored MATT System data to create and test a program that will generate, on a timely basis, action reports for district and headquarters personnel.

---

*Underlined numbers in parentheses refer to list of references.

OBJECTIVE

The major objectives of this project were to:

1. Check the validity of previously processed MATT System records.

2. Develop a computer program to generate the FHWA's Quality Index of a material from the MATT System data records.

3. Develop a computer program to generate information or action reports from the MATT System records.

METHOD OF PROCEDURE

To accomplish the stated objectives, the project was broken down into three phases according to those listed under objectives, primarily:

Phase 1 Review the MATT System files and records for validity of data.

Phase 2 Develop a computer program which uses the MATT System data records to generate the FHWA's Quality Index of a material.

Phase 3 Develop a computer program to generate information and action reports from MATT System files.

Phase 1

In this phase it was decided to review all MATT System Project Information and Roadway Cross-Section records. The type of information recorded on the MATT input forms is shown in Appendix A. These records contain information about the overall project, and thus each project that had such a record at the time of the study was reviewed. This was done by printing the record of each project on a special form. An example of this form is shown in Appendix A. To help in the reviewing process, the projects were broken down by district and type of construction. This also aided in the search for the type of invalid data. For example, if the type of construction was a rest area, there would be no need for an entry in surface thickness; but if the type of construction was HMAC, an entry for surface thickness should be found. Relationships between the data and the type of construction helped to guide the search for the invalid data entries.

The next step of Phase 1 was to review the MATT System materials test records. The volume of the data demanded that it be limited so that it could be checked more thoroughly. This was done by selecting random projects according to types of construction. This was done by listing all the projects by type of construction category that had been completed at the time of this study. From this list approximately 20 percent of the projects were randomly selected to represent that construction type. After selection of the representative projects, each of the 13 materials test files was output to hard copy for manual checking of valid data entry. For a list of the MATT System materials test files see Appendix B.

The types of invalid data which were searched for were items such as a missing or zero value. During review of the data, notes were made as to the type of invalid entries and the data fields where such entries were found. Appendix C lists the comments generated for this review of each MATT test file.

Phase 2

Phase 2 consisted of the development of a computer program which would compute the Quality Index of a construction material. This phase was completed in conjunction with the FHWA using their procedure to calculate the Quality Index as the algorithm for development of the computer program. Appendix D describes this procedure for calculation of this Quality Index. The program was written in SAS software package using the many data manipulation routines and procedures found within the language.

Phase 3

Phase 3 consisted of the development of a series of computer programs that would generate informative and action reports from MATT materials files.

The materials chosen for development of these programs were the major construction materials of the Department, hot mix asphaltic concrete and portland cement concrete. Appendix E is an example of the output generated from one of these programs.

The basic algorithms used for development of the varying programs were very similar. The only changes made to the programs were made to the input variables and to the materials properties upon which the statistical analysis was performed. The programs were written in such a way that they could be modified and used for specific purposes to meet the needs of the requestor. Appendix F is an example of one such report on structural concrete.

RESULTS

Phase 1

The result of Phase 1 was a series of comments which described the invalid entries found in each MATT System data file. These comments can be found in Appendix C.

Phase 2

Phase 2 of the study developed a program to calculate the Quality Level for hot mix asphaltic concrete construction. Using the procedure described in Appendix D, the Quality Level for roadway compaction was calculated for two construction projects. Appendix E shows the output generated by this Quality Level calculation program. Based on the criterion for distinguishing acceptable versus unacceptable construction as defined in item 10 of the Quality Index calculation procedure in Appendix D, improvement is needed in construction control on project 8-08-23.

Phase 3

Phase 3 of the study generated programs for hot mix asphaltic concrete, portland cement concrete and base course compaction. These programs generate "action reports" in terms of statistical evaluation on the test properties of the materials. See Appendix F for an example of the output generated for structural concrete. The output characterizes the statistical information according to several categories. Such reports are information oriented and provide trigger points for initiating action if so indicated by the evaluation.

Another example of such reports is indicated in the output showing the quantity of material that had reduced pay for concrete and hot mix. It also provides information relative to the quantity of the material used in a given year.

CONCLUSIONS AND RECOMMENDATIONS

All three phases of the MATT System project were completed successfully. The conclusions and recommendations on each phase of the projects are listed below:

Phase 1

The MATT System, based upon a validity check of each data file within the system, is, on a system-wide basis, very sound. There are areas where improvement could be made, but these areas are at the entry point of the data. More careful checking of the data entered within the system and a more sincere effort to enter all data no matter how insignificant the entry personnel deem the data would correct these problems. An alternate portion of the solution to the problem would be to rewrite the edit programs controlling the data files so that all data entries would be required before further processing and storage. However, the resources needed to rewrite the programs may make this alternative infeasible.

Phase 2

The program developed to generate the Quality Level for hot mix asphaltic concrete produces results which greatly reduce time when compared to manual calculations of the same type. The program can be adapted to performing such calculations for other highway construction materials.

Phase 3

The programs developed to generate the "action reports" are easily modified for specific situations. It is recommended that the programs be compiled and modified in such a manner that they will be available and easily used by anyone who desires such a report.

REFERENCES

1. Highway Condition and Quality of Highway Construction Survey Report (Final Report), published by U. S. Department of Transportation, Federal Highway Administration, July 1977.

APPENDIX A

MATT PROJECT INFORMATION AND ROADWAY CROSS-SECTION REVIEW FORM

PROJECT NUMBER ======>

F.A.P. ==============>

ROUTE ===============>

DISTRICT ============>

PARISH ==========#==>

PROJECT ENGINEER ====>

CONTRACTOR =======#==>

LOCATION (FROM-TO) ==>

BEGINNING MILEPOST ==>

ENDING MILEPOST =#==>

BEGINNING POINT =====>

ENDING POINT ========>

SYSTEM CODE =========>

URBAN OR RURAL ===#==>

WORK ORDER DATE =====>

BID COST =========#==>

ACCEPTANCE DATE =====>

FINAL COST =======#==>

DAYS ALLOCATED ======>

DAYS USED =========#==>

CONSTRUCTION TYPE ===>

NUMBER OF LANES ---->

PROJECT LENGTH ======>

ONE LANE WIDTH ====#==>

MEDIAN TYPE =========>

ADT ==============#==>

ROADWAY SURFACE =====>

THICKNESS =========#==>

JOINT INTERVAL ======>

REINFORCING =======#==>

LOAD TRANSFER DEVICE >

NEW OR OVERLAY ====#==>

EXISTING SURFACE ====>

ORIGINAL SURFACE ==#==>

BASE ================>

BASE THICKNESS ====#==>

SUBBASE =============>

SUBBASE THICKNESS ==#==>

SHOULDER SURFACE ====>

SHOULDER WIDTH ====#==>

SHOULDER BASE =======>

SHOULDER THICKNESS ==#==>

SUBGRADE SOIL =======>

MISC. INFORMATION ===>

APPENDIX B

LIST OF MATT SYSTEM MATERIALS TEST FILES

MATT SYSTEM FILES

FILE DESCRIPTION	TYPE OF FILE
Asphaltic Concrete Job Mix	Job Mix Formulas
Concrete Job Mix	Job Mix Formulas
Aggregate	Test Results
Asphalt Cement	Test Results
Liquid Asphalt	Test Results
Cement	Test Results
Structural Concrete	Test Results
Asphaltic Concrete	Test Results
Steel Wire	Test Results
Steel Bar	Test Results
Soil Analysis	Test Results
Density / Moisture	Test Results
Thickness / Width	Test Results
Project Information	Information
Roadway Cross-section	Information

APPENDIX C

COMMENTS ON MATT SYSTEM DATA FILES

STRUCTURAL CONCRETE

COMMENTS :

1.) In pretty good shape.

2.) Consistent on all values being entered.

RECOMMENDATIONS :

1.) Don not allow a zero break strength to be entered.

2.) If a field has a yes/no answer make sure a resulting value is entered.

ASPHALT CEMENT

COMMENTS :

1.) Has a lot of missing values in the following data fields :

Kinematic viscosity @ 140° F
Absolute viscosity @ 140° F
Solubility
Flash point
Residue viscosity @ 140° F
Ductility
Spot test
Specific gravity

RECOMMENDATIONS :

1.) Enter all necessary data.

LIQUID ASPHALT

COMMENTS :

1.) A lot of missing values in all data fields.

RECOMMENDATIONS :

1.) Enter all necessary data.

CEMENT

COMMENTS :

1.) In pretty good shape.

RECOMMENDATIONS :

1.) Do not all a quantity to be entered as zero.

PAVING CONCRETE

COMMENTS :

1.) Consistent on all data being entered.

RECOMMENDATIONS :

1.) Do not allow a zero section length or zero section width to be entered.

DENSITY / MOISTURE

COMMENTS :

1.) Data in pretty good shape.

2.) Some missing values in the following data fields

Dry rodded theoretical density
Optimum moisture content
Field moisture content
Percent pulverization

RECOMMENDATIONS :

1.) Enter all necessary data.

STEEL BAR

COMMENTS :

1.) Missing data values in the following data fields :

Date sampled
Quantity sampled
Date of test
Nominal diameter
Actual diameter
Difference in nominal and actual diameter
Out of roundness
Yield strength
Tensile strength
Elongation
Reduction in area
Phosphorus

RECOMMENDATIONS :

1.) Enter all necessary data.

STEEL WIRE

COMMENTS :

1.) Unusual values for quantity.

2.) Missing data values in the following data fields :

Out of roundness
Yield strength
Tensile strength
Elongation
Sulfur
Phosphorus

RECOMMENDATIONS :

1.) Enter all necessary data.

ASPHALTIC CONCRETE

COMMENTS :

1.) Missing values in the following data entry fields :

Station number (to & from)
Specific gravity
Marshall stability
Percent voids filled with asphalt
Briquet gravity
Tolerance
Linear feet
Linear feet outside tolerance
Density
All gradation data
Quantity

RECOMMENDATIONS :

1.) Enter all necessary data.

AGGREGATE

COMMENTS :

1.) Has a lot of missing values in the following data fields :

Percent passing 2 1/2"
Percent passing 2"
Percent passing 1 1/4"
Percent passing 1"
Percent passing 3/4"
Percent passing 5/8"
Percent passing 1/2"
Percent passing 3/8"
Percent passing # 8
Percent passing # 10
Percent passing # 16
Percent passing # 30
Percent passing # 40
Percent passing # 50
Percent passing # 80
Percent passing # 100
Percent passing # 200
Percent passing # 270
Absorption
Specific gravity - SSD
Specific gravity - APP
Dry loose weight
Dry rodded weight
Color
Clay lumps
Deleterious material
Decantation loss
Liquid limit
Plasticity index
Foreign matter
Sand equivalent
Glassy particles
Alkalinity
Polish value
Abrasion
Coating on particles
Soundness
Asphalt content
Percent crushed
Soft fragments

RECOMMENDATIONS :

1.) Enter all necessary data.

APPENDIX D

FHWA PROCEDURE FOR CALCULATING THE QUALITY INDEX OF A MATERIAL

QUALITY INDEX PROCEDURE

This is a rapid and easy method of estimating the quality level of material and construction quality control factors.

1. Randomly select a segment (a minimum of 3 production days) of recently completed work. List all the results of tests or measurements for the characteristics being analyzed. (ie - air content, thickness, bitumen content, etc.).

2. Average the test results to find the mean X-bar.

3. Find the range (R) by subtracting the smallest test value from the largest value. When the number of tests is 10 or more arrange the test results consecutively in subgroups of five. Find the range for each subgroup of five and compute the average range (R-bar).

4. Find the upper quality index (Q_u) by subtracting the average (X-bar) from the upper specification limit (U.L.) and dividing by the range (R) or (R-bar).

$$Q_U = (U.L. - X\text{-bar}) / R \text{ or } R\text{-bar}$$

5. Find the lower Quality Index (Q_L) by subtracting the lower specification limit (L.L.) from the average (X-bar) and dividing by the range (R).

$$Q_L = (X\text{-bar} - L.L.) / R \text{ or } R\text{-bar}$$

6. Estimate the percent that will fall within the upper specification limit (P_U) by entering the attached Table with Q_U, using the column appropriate to the total number of measurements. Note that the sign of Q_U or Q_L whether positive or negative, must be taken into account.

7. Estimate the percent that will fall within the lower specification limit (P_L) by entering the attached Table with Q_L, using the column appropriate to the total number of measurements.

8. Where both upper (U.L.) and lower (L.L.) specification limits are applicable, find the percent of material within these limits by adding the percent within the upper limit (P_U) to the percent within the lower limit (P_L) and subtracting 100.

$$P_T(\text{Total percent within limits}) = (P_U + P_L) - 100.$$

9. Where only one specification limit is applicable, U.L. or L.L., the percent within tolerance is that value obtained directly from the attached Table.

10. A 90 percent Quality Index has been chosen by the FHWA on the basis of engineering judgment as the dividing criterion which distinguishes between a good quality level of work and levels where improvements are needed.

TABLE FOR ESTIMATING PERCENT OF LOT WITHIN TOLERANCE

BY RANGE METHOD

Percent Within Tolerance	POSITIVE VALUES OF Q_U OR Q_L												
	$n=3$	$n=4$	$n=5$	$n=6$	$n=7$	$n=10$*	$n=15$*	$n=25$*	$n=30$*	$n=35$*	$n=40$*	$n=50$*	$n=60$*
99	0.60	0.66	0.66	0.65	0.65	0.82	0.88	0.93	0.94	0.95	0.95	0.97	0.97
98	0.60	0.64	0.65	0.62	0.61	0.76	0.80	0.83	0.84	0.85	0.85	0.86	0.86
97	0.60	0.63	0.62	0.59	0.58	0.71	0.74	0.77	0.78	0.78	0.78	0.79	0.79
96	0.60	0.62	0.60	0.57	0.55	0.68	0.68	0.72	0.73	0.73	0.73	0.74	0.74
95	0.60	0.60	0.58	0.55	0.53	0.64	0.66	0.68	0.68	0.69	0.69	0.70	0.70
94	0.59	0.59	0.57	0.53	0.51	0.62	0.63	0.64	0.65	0.65	0.66	0.66	0.66
93	0.59	0.58	0.55	0.51	0.49	0.59	0.61	0.61	0.62	0.62	0.62	0.62	0.62
92	0.59	0.56	0.53	0.49	0.47	0.57	0.58	0.59	0.59	0.59	0.59	0.60	0.60
91	0.58	0.55	0.51	0.48	0.46	0.54	0.55	0.56	0.57	0.57	0.57	0.57	0.57
90	0.58	0.54	0.50	0.46	0.44	0.52	0.53	0.54	0.54	0.54	0.54	0.55	0.55
89	0.57	0.52	0.48	0.45	0.43	0.50	0.51	0.52	0.52	0.52	0.52	0.52	0.52
88	0.56	0.51	0.46	0.43	0.41	0.48	0.49	0.50	0.50	0.50	0.50	0.50	0.50
87	0.55	0.50	0.45	0.42	0.40	0.47	0.47	0.47	0.48	0.48	0.48	0.48	0.48
86	0.54	0.48	0.44	0.40	0.38	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.46
85	0.54	0.47	0.42	0.39	0.37	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.44
84	0.53	0.46	0.41	0.38	0.36	0.42	0.42	0.42	0.43	0.43	0.43	0.42	0.42
83	0.52	0.44	0.40	0.36	0.34	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.41
82	0.51	0.43	0.38	0.35	0.33	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
81	0.50	0.42	0.37	0.34	0.32	0.37	0.37	0.37	0.37	0.37	0.38	0.38	0.38
80	0.49	0.40	0.36	0.33	0.31	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
79	0.48	0.39	0.34	0.31	0.29	0.34	0.34	0.34	0.34	0.34	0.35	0.35	0.35
78	0.47	0.38	0.33	0.30	0.28	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
77	0.46	0.36	0.32	0.29	0.27	0.32	0.32	0.31	0.31	0.32	0.32	0.32	0.32
76	0.44	0.35	0.30	0.28	0.26	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
75	0.43	0.34	0.29	0.27	0.25	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
74	0.41	0.32	0.28	0.25	0.24	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
73	0.40	0.31	0.27	0.24	0.23	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27
72	0.39	0.30	0.25	0.23	0.22	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
71	0.37	0.28	0.24	0.22	0.20	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
70	0.36	0.27	0.23	0.21	0.19	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.23
69	0.34	0.26	0.22	0.20	0.18	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
68	0.32	0.24	0.21	0.19	0.17	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
67	0.31	0.23	0.19	0.18	0.16	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
66	0.29	0.21	0.18	0.17	0.15	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
65	0.27	0.20	0.17	0.16	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
64	0.26	0.19	0.16	0.15	0.13	0.15	0.16	0.15	0.15	0.15	0.15	0.15	0.15
63	0.24	0.17	0.15	0.13	0.12	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
62	0.22	0.16	0.14	0.12	0.11	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
61	0.20	0.15	0.13	0.11	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
60	0.19	0.13	0.11	0.10	0.09	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
55	0.09	0.07	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*When n is 10 or more, the samples are arranged consecutively in subgroups of five. Then the range R of each subgroup is determined, and the average $\bar{R}$ of the ranges of all the subgroups is computed for use in finding Q_U of Q_L.

TABLE FOR ESTIMATING PERCENT OF LOT WITHIN TOLERANCE

BY RANGE METHOD

Percent Within Tolerance	NEGATIVE VALUES OF Q_U OR Q_L												
	$n=3$	$n=4$	$n=5$	$n=6$	$n=7$	$n=10$*	$n=15$*	$n=25$*	$n=30$*	$n=35$*	$n=40$*	$n=50$*	$n=60$*
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	0.09	0.07	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
40	0.19	0.13	0.11	0.10	0.09	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
39	0.20	0.15	0.13	0.11	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
38	0.22	0.16	0.14	0.12	0.11	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
37	0.24	0.17	0.15	0.13	0.12	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
36	0.26	0.19	0.16	0.15	0.13	0.15	0.16	0.15	0.15	0.15	0.15	0.15	0.15
35	0.27	0.20	0.17	0.16	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
34	0.29	0.21	0.18	0.17	0.15	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
33	0.31	0.23	0.19	0.18	0.16	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
32	0.32	0.24	0.21	0.19	0.17	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
31	0.34	0.26	0.22	0.20	0.18	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
30	0.36	0.27	0.23	0.21	0.19	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23
29	0.37	0.28	0.24	0.22	0.20	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
28	0.39	0.30	0.25	0.23	0.22	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
27	0.40	0.31	0.27	0.24	0.23	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
26	0.41	0.32	0.28	0.25	0.24	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
25	0.43	0.34	0.29	0.27	0.25	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
24	0.44	0.35	0.30	0.28	0.26	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
23	0.46	0.36	0.32	0.29	0.27	0.32	0.32	0.31	0.31	0.32	0.32	0.32	0.32
22	0.47	0.38	0.33	0.30	0.28	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
21	0.48	0.39	0.34	0.31	0.29	0.34	0.34	0.34	0.34	0.34	0.35	0.35	0.35
20	0.49	0.40	0.36	0.33	0.31	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
19	0.50	0.42	0.37	0.34	0.32	0.37	0.37	0.37	0.37	0.37	0.38	0.38	0.38
18	0.51	0.43	0.38	0.35	0.33	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
17	0.52	0.44	0.40	0.36	0.34	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.41
16	0.53	0.46	0.41	0.38	0.36	0.42	0.42	0.42	0.43	0.43	0.43	0.42	0.42
15	0.54	0.47	0.42	0.39	0.37	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.44
14	0.54	0.48	0.44	0.40	0.38	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.46
13	0.55	0.50	0.45	0.42	0.40	0.47	0.47	0.47	0.48	0.48	0.48	0.48	0.48
12	0.56	0.51	0.46	0.43	0.41	0.48	0.49	0.50	0.50	0.50	0.50	0.50	0.50
11	0.57	0.52	0.48	0.45	0.43	0.50	0.51	0.52	0.52	0.52	0.52	0.52	0.52
10	0.58	0.54	0.50	0.46	0.44	0.52	0.53	0.54	0.54	0.54	0.54	0.55	0.55
9	0.58	0.55	0.51	0.48	0.46	0.54	0.55	0.56	0.57	0.57	0.57	0.57	0.57
8	0.59	0.56	0.53	0.49	0.47	0.57	0.58	0.59	0.59	0.59	0.59	0.60	0.60
7	0.59	0.58	0.55	0.51	0.49	0.59	0.61	0.61	0.62	0.62	0.62	0.62	0.62
6	0.59	0.59	0.57	0.53	0.51	0.62	0.63	0.64	0.65	0.65	0.66	0.66	0.66
5	0.60	0.60	0.58	0.55	0.53	0.64	0.66	0.68	0.68	0.69	0.69	0.70	0.70
4	0.60	0.62	0.60	0.57	0.55	0.68	0.68	0.72	0.73	0.73	0.73	0.74	0.74
3	0.60	0.63	0.62	0.59	0.58	0.71	0.74	0.77	0.78	0.78	0.78	0.79	0.79
2	0.60	0.64	0.65	0.62	0.61	0.76	0.80	0.83	0.84	0.85	0.85	0.86	0.86
1	0.60	0.66	0.66	0.65	0.65	0.82	0.88	0.93	0.94	0.95	0.95	0.97	0.97

*When n is 10 or more, the samples are arranged consecutively in subgroups of five. Then the range R of each subgroup is determined, and the average $\bar{R}$ of the ranges of all the subgroups is computed for use in finding Q_U or Q_L.

APPENDIX E

EXAMPLE OF OUTPUT FROM

QUALITY INDEX GENERATION PROGRAM

PROJECET NUMBER - 008-08-23

LOT NUMBER	NUMBER OF SAMPLES	AVERAGE COMPACTION PER LOT	RANGE OF COMPACTION
165	5	95.9	0.9
166	5	94.2	1.3
167	5	95.2	1.8
168	5	95.0	1.8

4 LOT STATISTICS - AVERAGE RANGE : 1.5
- AVERAGE COMPACTION : 95.1
- QUALITY INDEX : 0.05
- PERCENT WITHIN TOLRANCE : 54

170	5	95.2	1.8
186	5	93.3	1.3
187	5	95.3	3.0
188	5	95.4	3.4

4 LOT STATISTICS - AVERAGE RANGE : 2.4
- AVERAGE COMPACTION : 94.8
- QUALITY INDEX : -0.08
- PERCENT WITHIN TOLRANCE : 43

189	5	96.5	1.2
190	5	95.7	2.1
191	5	96.1	2.1
192	5	95.0	4.7

4 LOT STATISTICS - AVERAGE RANGE : 2.5
- AVERAGE COMPACTION : 95.8
- QUALITY INDEX : 0.33
- PERCENT WITHIN TOLRANCE : 78

PROJECET NUMBER - 071-01-15

LOT NUMBER	NUMBER OF SAMPLES	AVERAGE COMPACTION PER LOT	RANGE OF COMPACTION
051	5	95.6	3.3
052	5	96.7	4.5
052	5	95.6	2.0
054	5	95.9	1.2

4 LOT STATISTICS - AVERAGE RANGE : 2.8
- AVERAGE COMPACTION : 95.9
- QUALITY INDEX : 0.35
- PERCENT WITHIN TOLRANCE : 79

055	5	95.1	1.2
056	5	96.0	1.6
057	5	96.1	1.2
058	5	95.1	0.8

4 LOT STATISTICS - AVERAGE RANGE : 1.2
- AVERAGE COMPACTION : 95.6
- QUALITY INDEX : 0.48
- PERCENT WITHIN TOLRANCE : 89

059	5	96.5	1.2
060	5	95.6	1.7
066	5	95.9	3.3
076	5	98.6	3.3

4 LOT STATISTICS - AVERAGE RANGE : 2.4
- AVERAGE COMPACTION : 96.6
- QUALITY INDEX : 0.69
- PERCENT WITHIN TOLRANCE : 100

APPENDIX F

EXAMPLE OF OUTPUT FROM

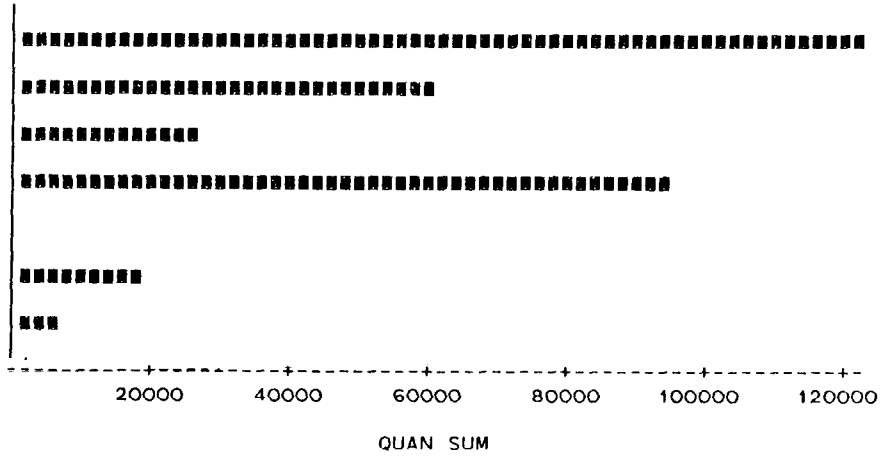
ACTION REPORT GENERATION PROGRAM

QUANTITY FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF SUMS



CODE	FREQ	QUAN SUM
A	3365	121022.4
A (MINOR)	2493	60759.3
A(M)	252	25337.0
AA	2020	94524.7
AA(M)	6	48.0
R	801	18971.2
S	195	5562.9

QUANTITY FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF SUMS

CODE	DIST	DISTRICT	FREQ	QUAN SUM
A	2		848	60182.00
	3		405	11027.50
	4		452	11186.20
	5		118	2671.50
	7		280	7308.10
	8		978	19767.80
	58		19	325.50
	61		153	3015.30
	62		112	5538.50
A (MINOR)	2		456	17727.10
	3		59	1380.00
	4		530	13381.80
	5		176	4430.60
	7		231	6293.60
	8		210	4662.40
	58		22	744.30
	61		407	4411.80
	62		402	7727.70
A(M)	2		110	12096.50
	3		0	0.00
	4		142	13240.50
	5		0	0.00
	7		0	0.00
	8		0	0.00
	58		0	0.00
	61		0	0.00
	62		0	0.00
AA	2		433	36010.80
	3		189	6348.30
	4		358	14825.40
	5		138	4581.20
	7		131	5936.00
	8		577	21523.60
	58		12	210.10
	61		151	4170.80
	62		31	918.50
AA(M)	2		1	17.00
	3		0	0.00
	4		5	31.00
	5		0	0.00
	7		0	0.00
	8		0	0.00
	58		0	0.00
	61		0	0.00
	62		0	0.00

QUANTITY FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF SUMS

CODE	DIST	DISTRICT	FREQ	QUAN SUM
R	2		0	0.00
	3	■	20	599.30
	4	■■■■■	147	3395.40
	5	■■■■	111	3322.50
	7	■■	51	1265.00
	8	■■■■■■■■■■■	391	8507.00
	58		3	150.00
	61	■	24	442.50
	62	■■	54	1289.50
S	2		0	0.00
	3		0	0.00
	4	■■■■■■	153	4599.50
	5		0	0.00
	7		0	0.00
	8	■	42	963.40
	58		0	0.00
	61		0	0.00
	62		0	0.00

6000 12000 18000 24000 30000 36000 42000 48000 54000 60000

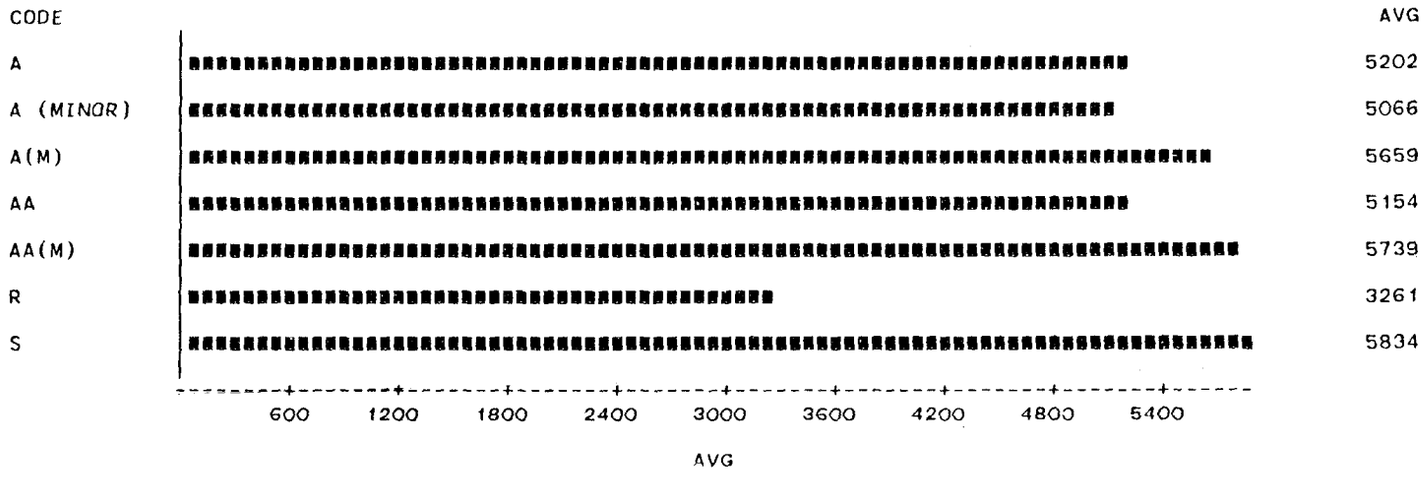
QUAN SUM

STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF AVG

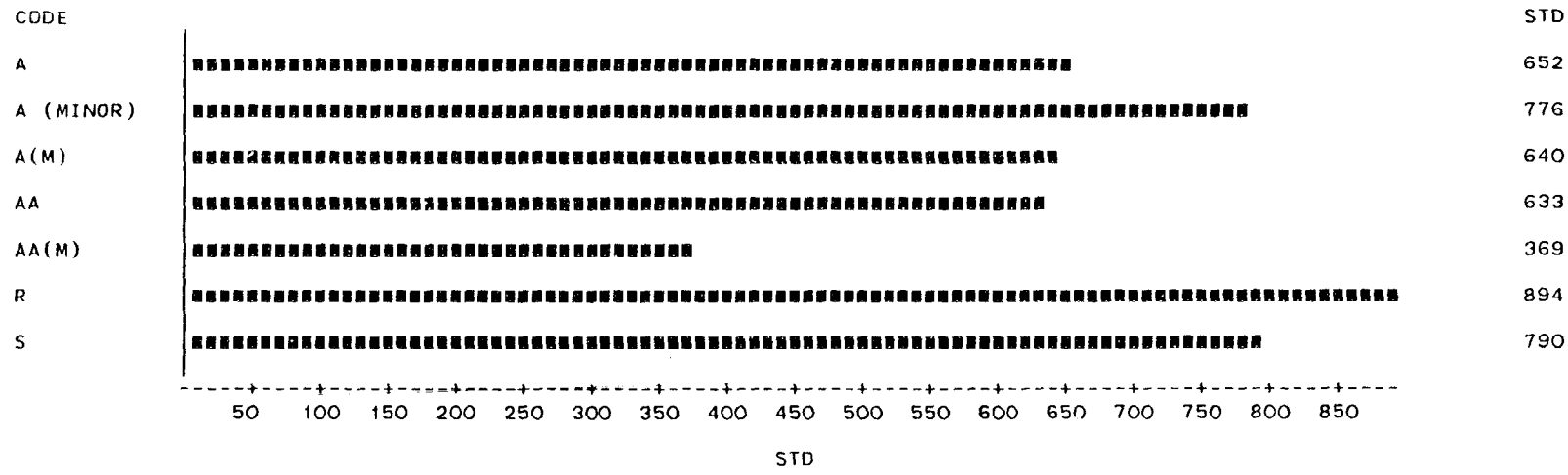


STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF STD

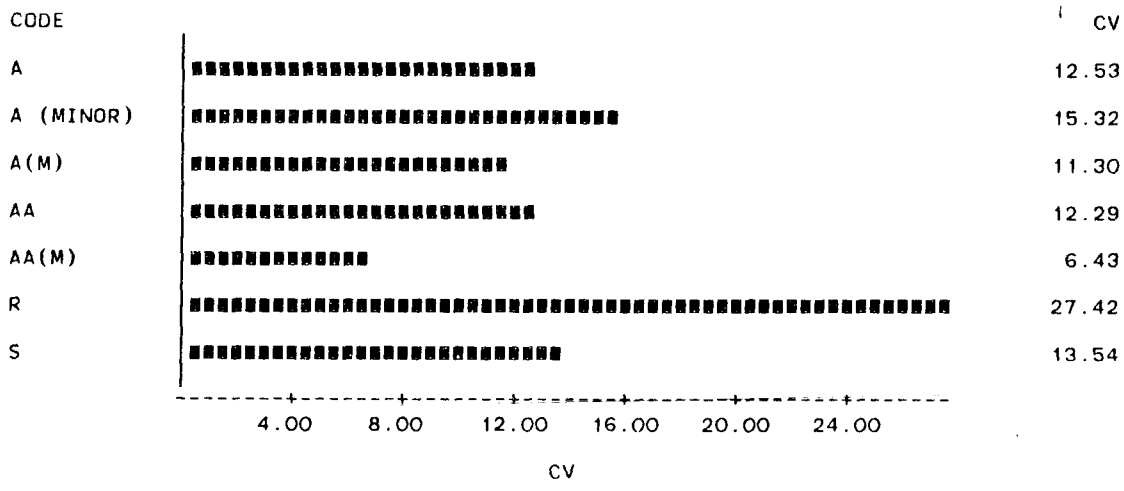


STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF CV



STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF AVG

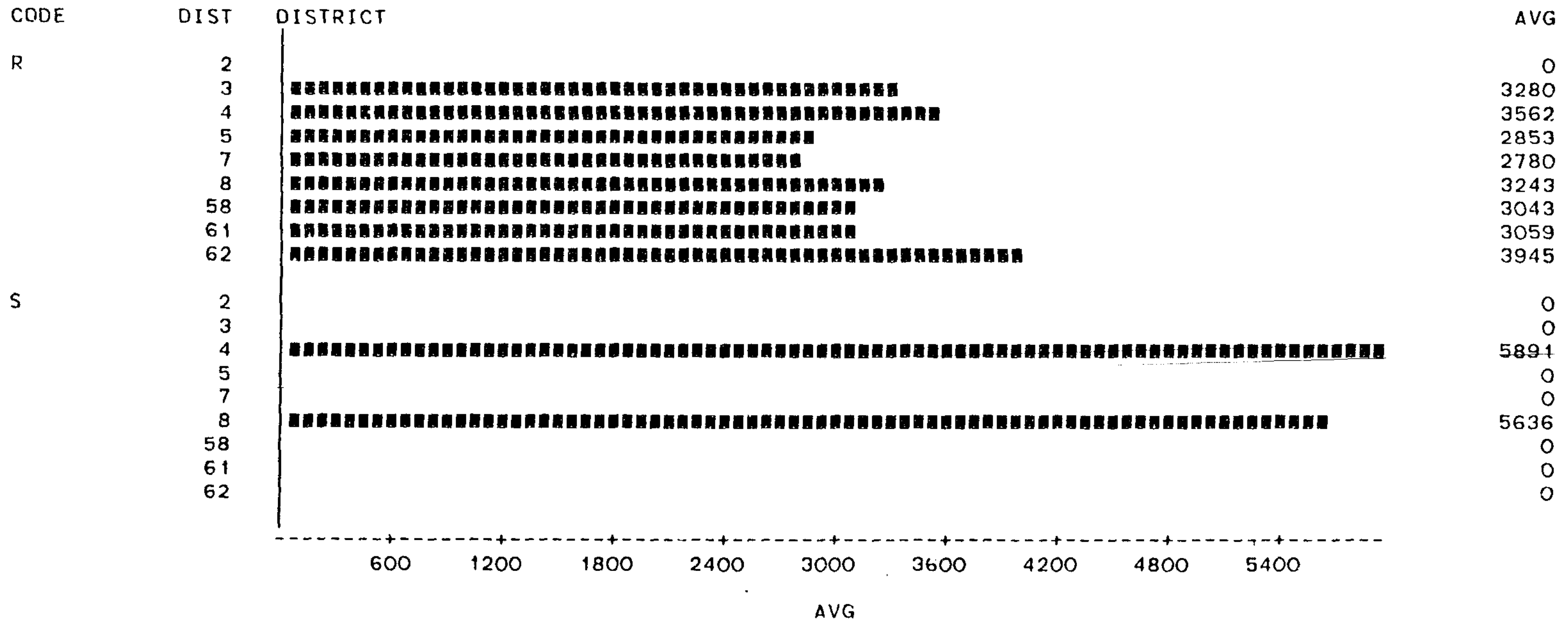
CODE	DIST	DISTRICT	AVG
A	2		5364
	3		4913
	4		5422
	5		4715
	7		5207
	8		5187
	58		4493
	61		5338
	62		4765
A (MINOR)	2		5137
	3		4816
	4		5057
	5		4374
	7		5681
	8		5161
	58		3904
	61		5314
	62		4739
A(M)	2		5787
	3		0
	4		5561
	5		0
	7		0
	8		0
	58		0
	61		0
	62		0
AA	2		5184
	3		5035
	4		5455
	5		4844
	7		4893
	8		5120
	58		4619
	61		5296
	62		4910
AA(M)	2		5294
	3		0
	4		5887
	5		0
	7		0
	8		0
	58		0
	61		0
	62		0

STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF AVG



STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF STD

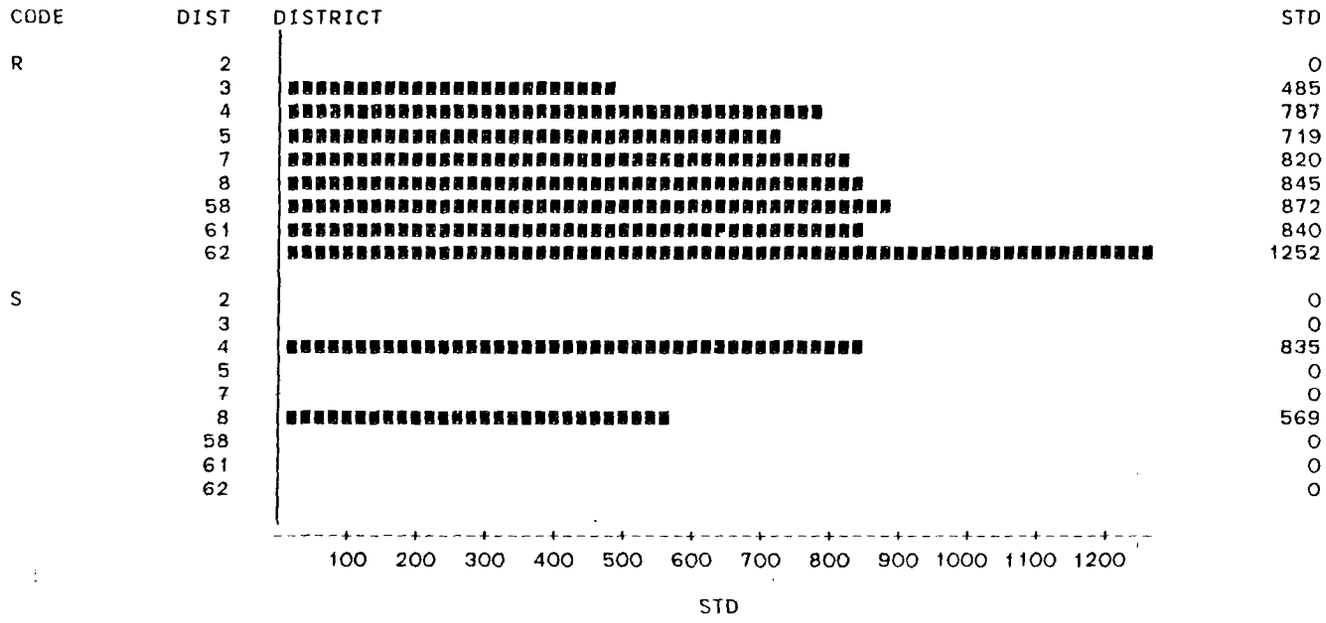
CODE	DIST	DISTRICT	STD
A	2		634
	3		418
	4		703
	5		507
	7		617
	8		617
	58		220
	61		708
	62		743
A (MINOR)	2		635
	3		637
	4		703
	5		600
	7		862
	8		745
	58		441
	61		793
	62		607
A(M)	2		513
	3		0
	4		707
	5		0
	7		0
	8		0
	58		0
	61		0
	62		0
AA	2		720
	3		361
	4		613
	5		560
	7		531
	8		597
	58		376
	61		647
	62		596
AA(M)	2		194
	3		0
	4		282
	5		0
	7		0
	8		0
	58		0
	61		0
	62		0

STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF STD



STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF CV

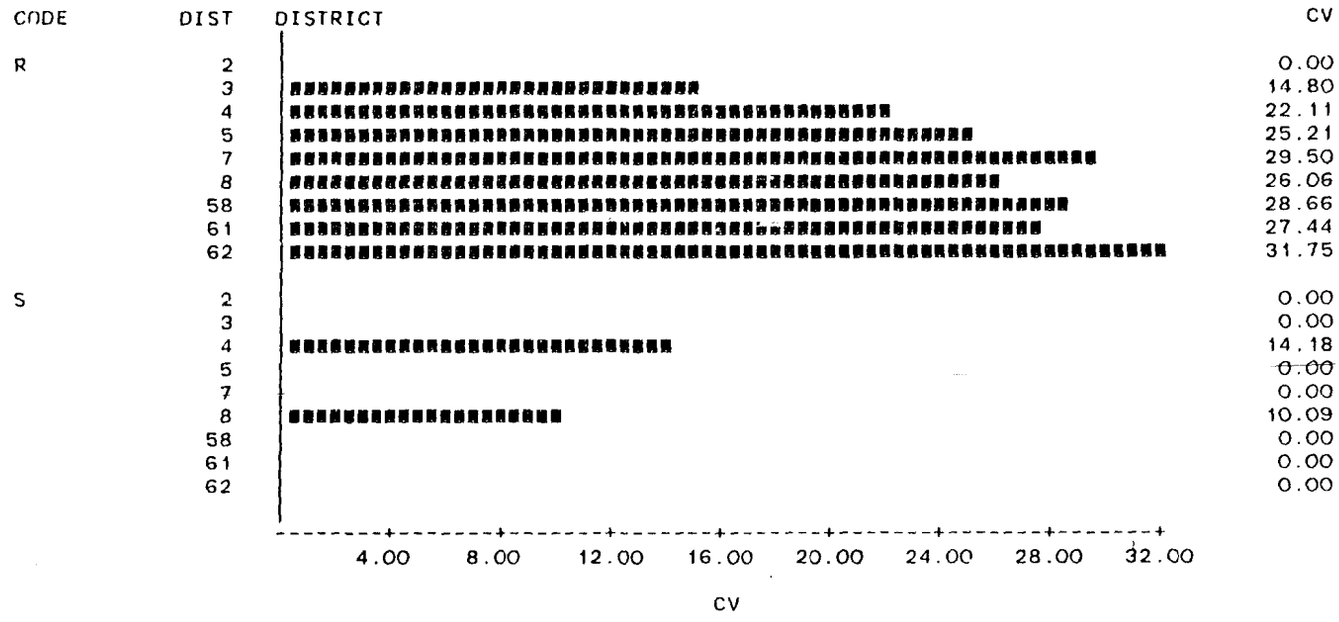
CODE	DIST	CV
A	2	11.81
	3	8.51
	4	12.96
	5	10.76
	7	11.85
	8	11.89
	58	4.89
	61	13.27
	62	15.60
A (MINOR)	2	12.36
	3	13.23
	4	13.91
	5	13.72
	7	15.17
	8	14.43
	58	11.30
	61	14.92
	62	12.80
A(M)	2	8.87
	3	0.00
	4	12.71
	5	0.00
	7	0.00
	8	0.00
	58	0.00
	61	0.00
	62	0.00
AA	2	13.89
	3	7.17
	4	11.25
	5	11.57
	7	10.84
	8	11.65
	58	8.13
	61	12.22
	62	12.13
AA(M)	2	3.66
	3	0.00
	4	4.79
	5	0.00
	7	0.00
	8	0.00
	58	0.00
	61	0.00
	62	0.00

STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF CV

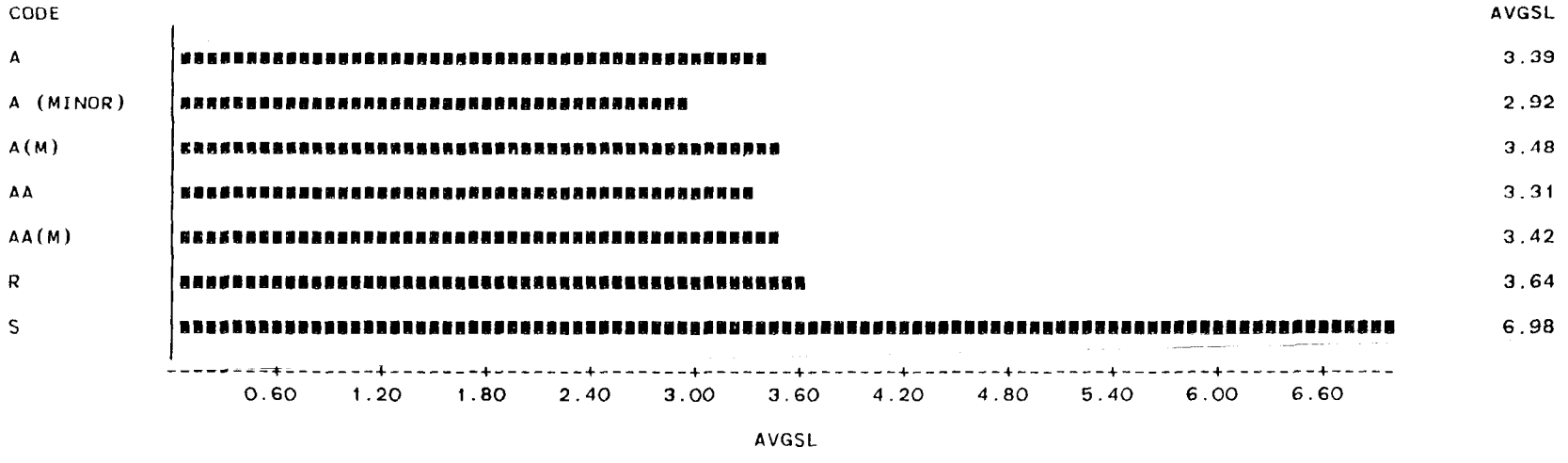


SLUMP STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF AVGSL

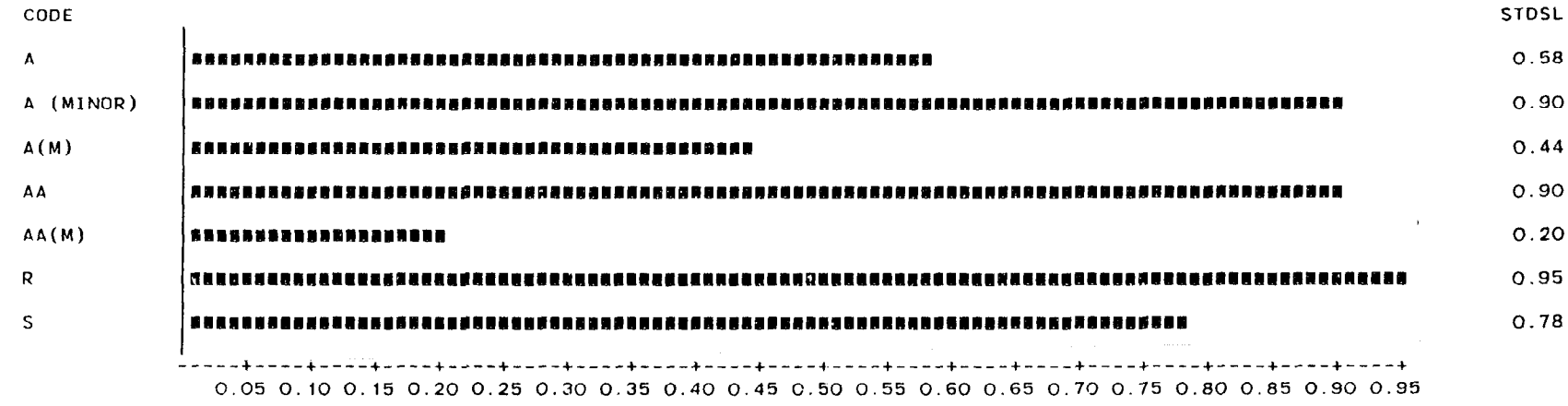


SLUMP STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF STDSL

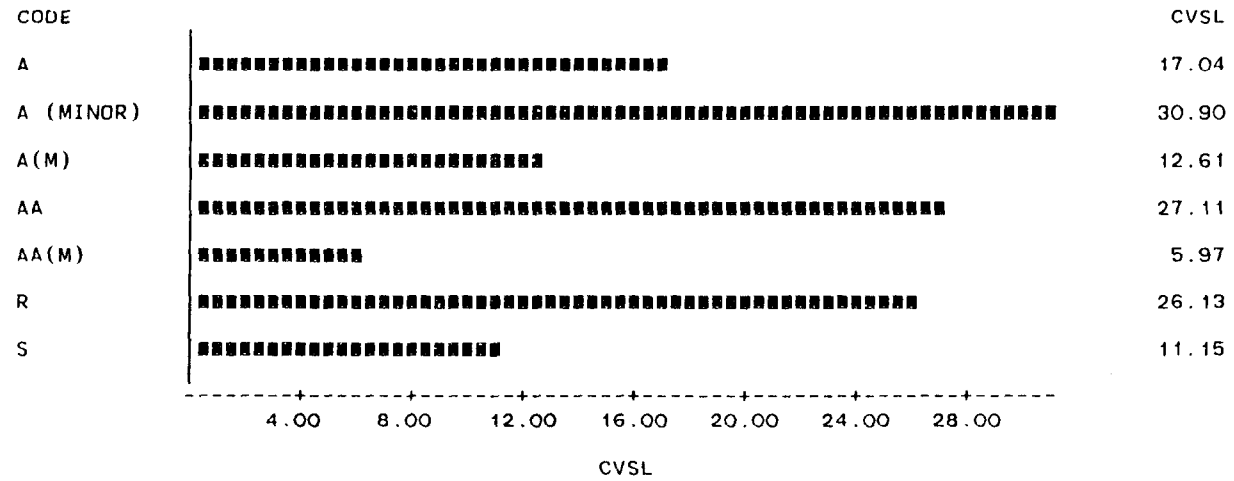


SLUMP STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF CVSL

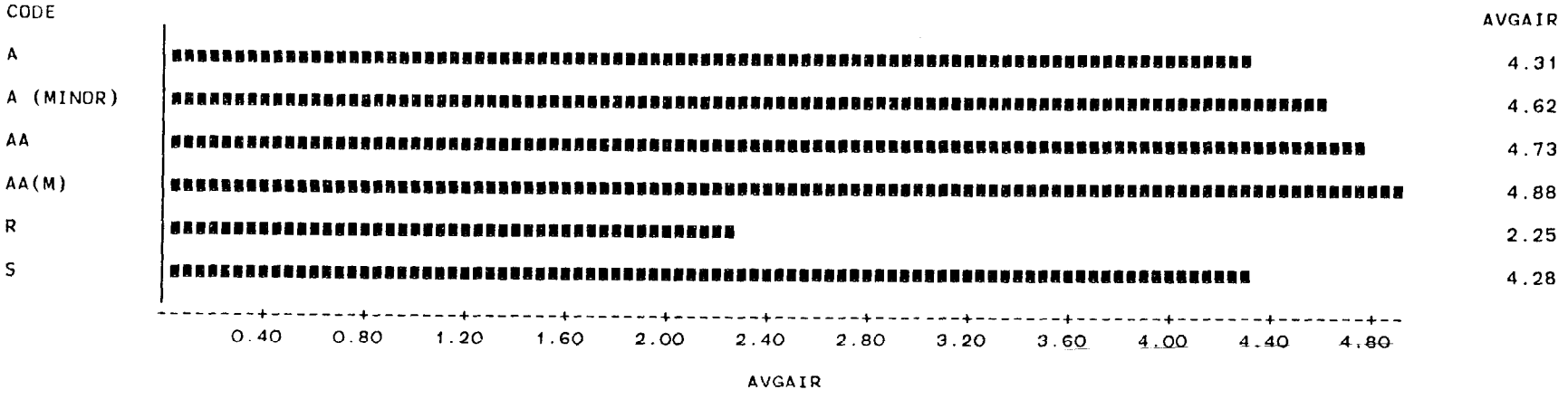


AIR CONTENT STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF AVGAIR

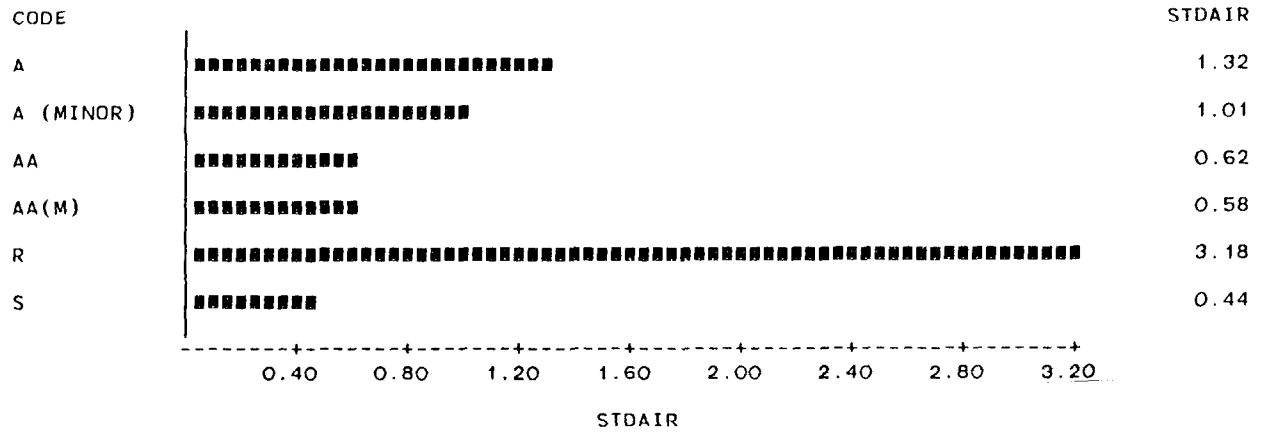


AIR CONTENT STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF STDAIR

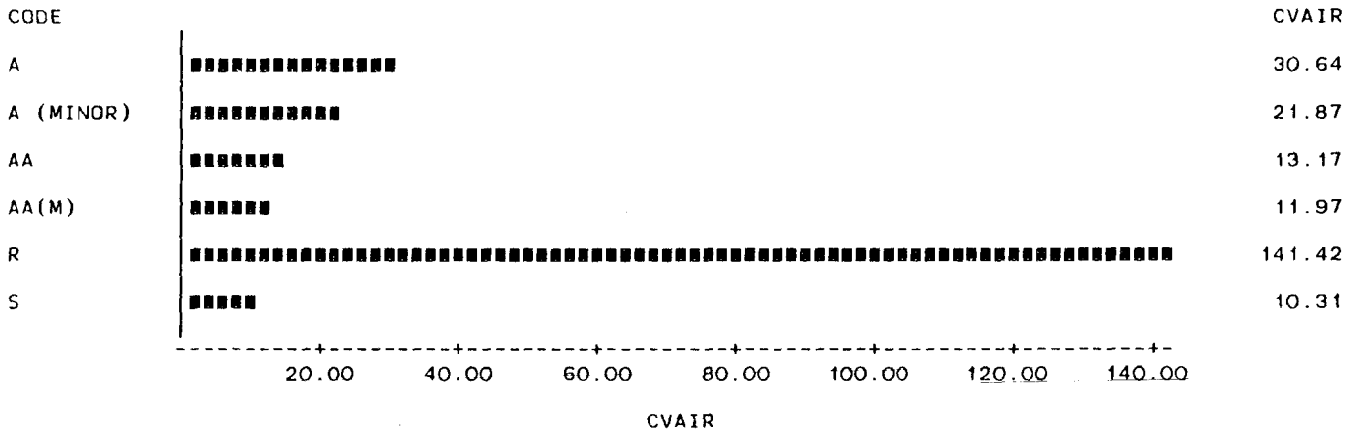


AIR CONTENT STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE ENTIRE STATE

BAR CHART OF CVAIR



SLUMP STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF AVGSL

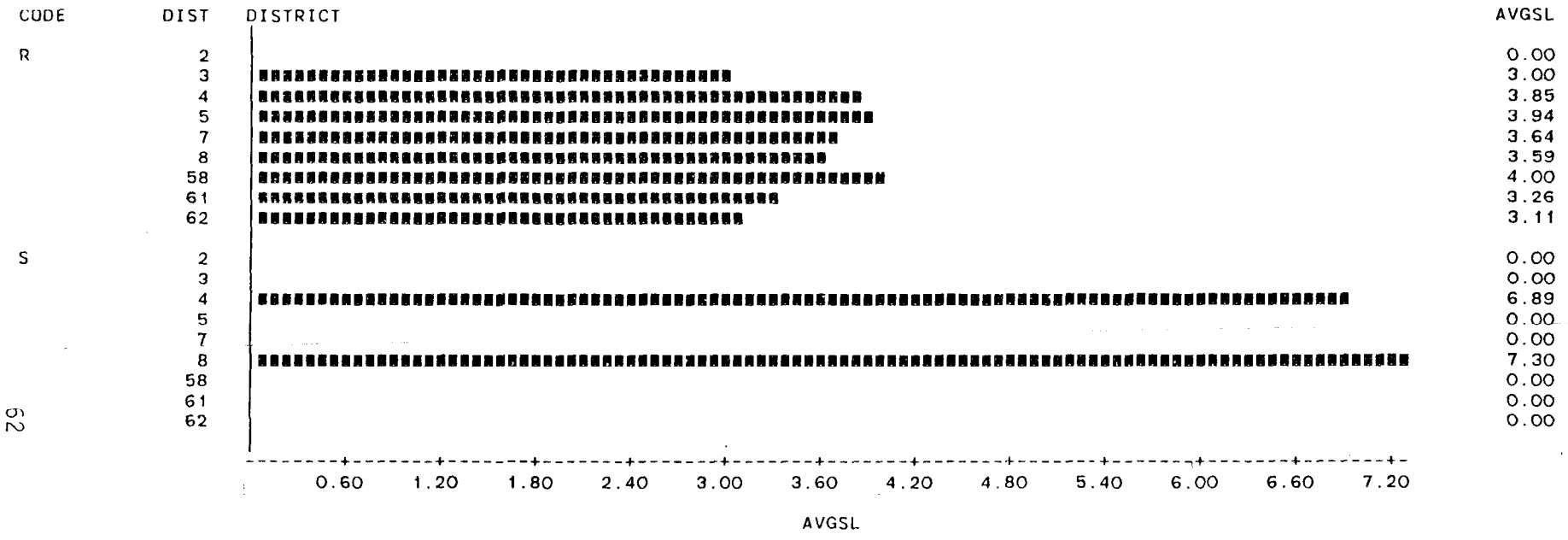
CODE	DIST	AVGSL
A	2	3.41
	3	3.30
	4	3.31
	5	3.42
	7	3.32
	8	3.48
	58	3.50
	61	3.25
	62	3.55
A (MINOR)	2	2.62
	3	3.07
	4	3.05
	5	3.35
	7	2.56
	8	2.98
	58	3.57
	61	3.14
	62	2.88
A(M)	2	3.61
	3	0.00
	4	3.38
	5	0.00
	7	0.00
	8	0.00
	58	0.00
	61	0.00
	62	0.00
AA	2	3.53
	3	3.19
	4	3.13
	5	3.29
	7	3.27
	8	3.34
	58	3.46
	61	3.18
	62	3.24
AA(M)	2	3.50
	3	0.00
	4	3.40
	5	0.00
	7	0.00
	8	0.00
	58	0.00
	61	0.00
	62	0.00

SLUMP STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF AVGSL



SLUMP STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF STDSL

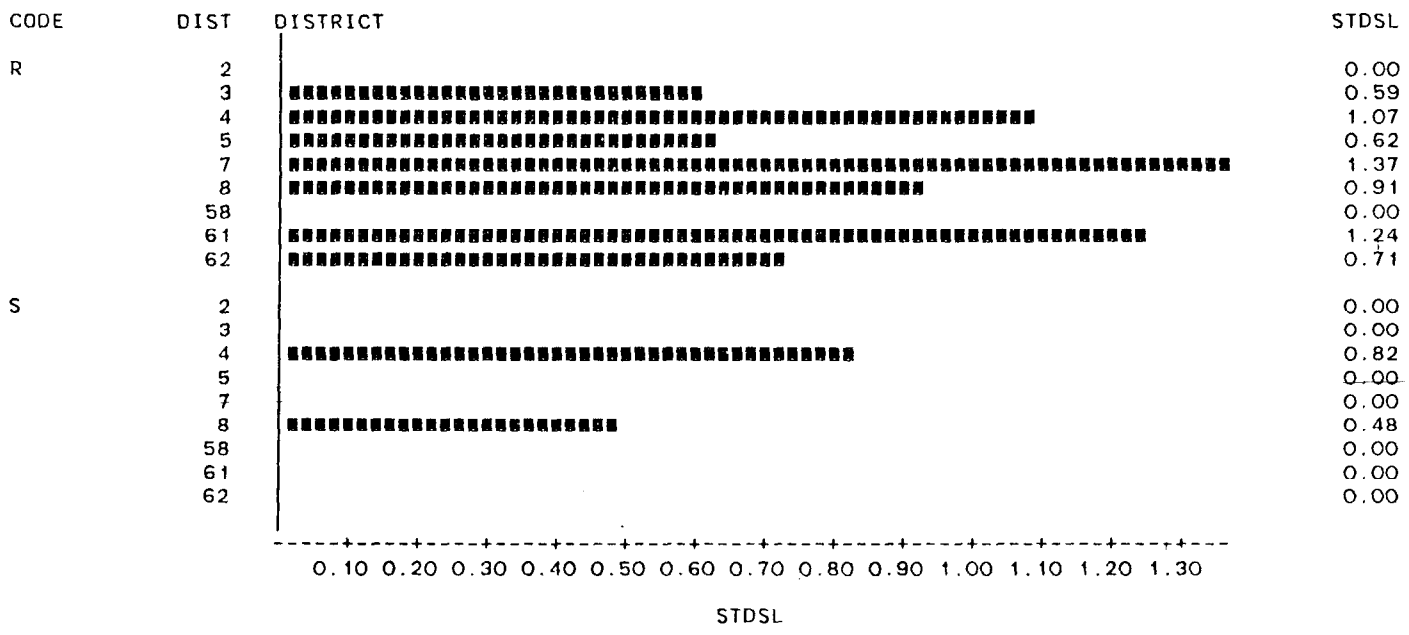
CODE	DIST	DISTRICT	STDSL
A	2		0.63
	3		0.51
	4		0.52
	5		0.49
	7		0.54
	8		0.56
	58		0.42
	61		0.58
	62		0.76
A (MINOR)	2		1.28
	3		0.83
	4		0.74
	5		0.54
	7		0.85
	8		1.18
	58		0.84
	61		0.47
	62		0.68
A(M)	2		0.28
	3		0.00
	4		0.51
	5		0.00
	7		0.00
	8		0.00
	58		0.00
	61		0.00
	62		0.00
AA	2		1.19
	3		0.64
	4		0.87
	5		0.65
	7		0.81
	8		0.86
	58		0.38
	61		0.63
	62		0.50
AA(M)	2		0.00
	3		0.00
	4		0.22
	5		0.00
	7		0.00
	8		0.00
	58		0.00
	61		0.00
	62		0.00

SLUMP STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF STDSL



SLUMP STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF CVSL

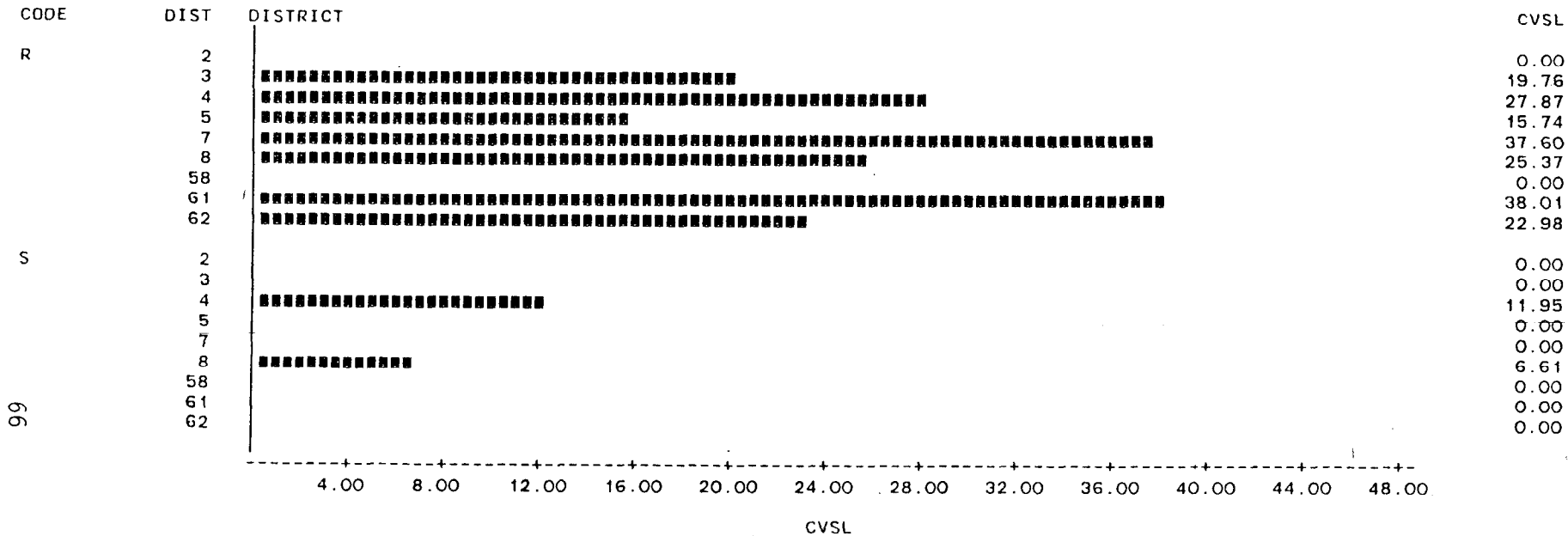
CODE	DIST	DISTRICT	CVSL
A	2		18.45
	3		15.41
	4		15.71
	5		14.23
	7		16.30
	8		16.23
	58		11.89
	61		17.73
	62		21.46
A (MINOR)	2		48.69
	3		27.21
	4		24.36
	5		16.00
	7		33.09
	8		39.55
	58		23.51
	61		14.90
	62		23.59
A(M)	2		7.64
	3		0.00
	4		14.95
	5		0.00
	7		0.00
	8		0.00
	58		0.00
	61		0.00
	62		0.00
AA	2		33.59
	3		19.90
	4		27.71
	5		19.92
	7		24.81
	8		25.76
	58		11.05
	61		19.94
	62		15.53
AA(M)	2		0.00
	3		0.00
	4		6.58
	5		0.00
	7		0.00
	8		0.00
	58		0.00
	61		0.00
	62		0.00

SLUMP STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF CVSL



AIR CONTENT STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF AVGAIR

CODE	DIST	AVGAIR
A	2	2.8
	3	4.8
	4	4.3
	5	4.7
	7	6.0
	8	4.5
	58	4.3
	61	3.2
	62	4.5
A (MINOR)	2	4.8
	3	5.0
	4	4.5
	5	0.0
	7	0.0
	8	4.1
	58	5.0
	61	3.3
	62	4.8
A(M)	2	0.0
	3	0.0
	4	0.0
	5	0.0
	7	0.0
	8	0.0
	58	0.0
	61	0.0
	62	0.0
AA	2	4.7
	3	4.5
	4	4.8
	5	4.7
	7	5.0
	8	4.7
	58	4.8
	61	4.7
	62	4.8
AA(M)	2	4.0
	3	0.0
	4	5.1
	5	0.0
	7	0.0
	8	0.0
	58	0.0
	61	0.0
	62	0.0

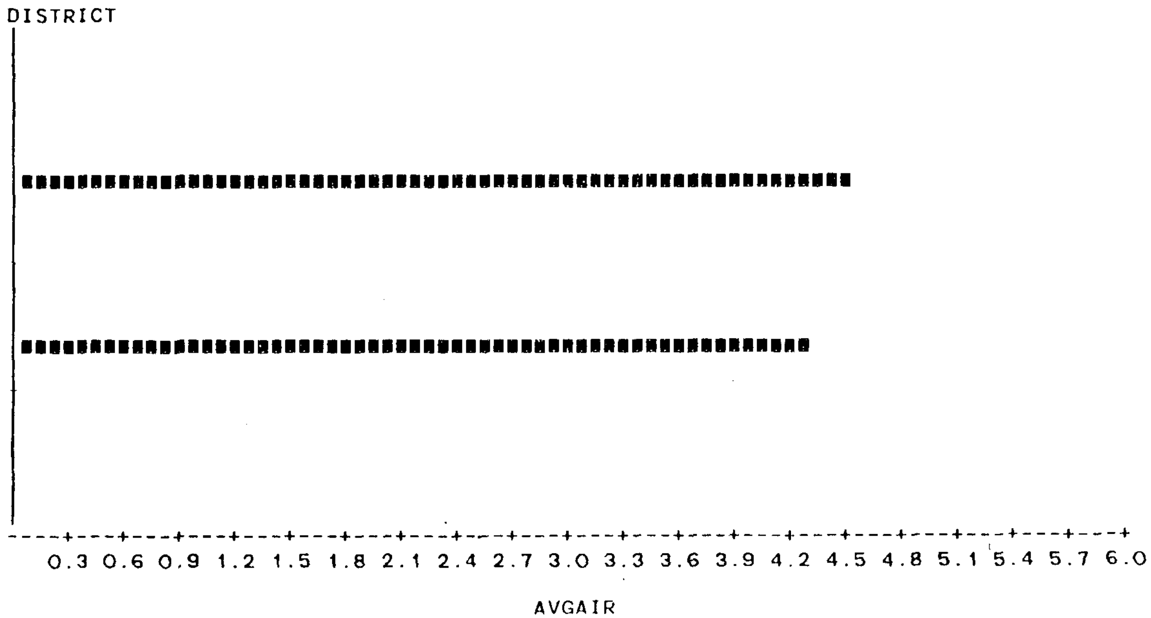
AIR CONTENT STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF AVGAIR

CODE	DIST	AVGAIR
R	2	0.0
	3	0.0
	4	0.0
	5	0.0
	7	0.0
	8	4.5
	58	0.0
	61	0.0
	62	0.0
S	2	0.0
	3	0.0
	4	4.3
	5	0.0
	7	0.0
	8	0.0
	58	0.0
	61	0.0
	62	0.0

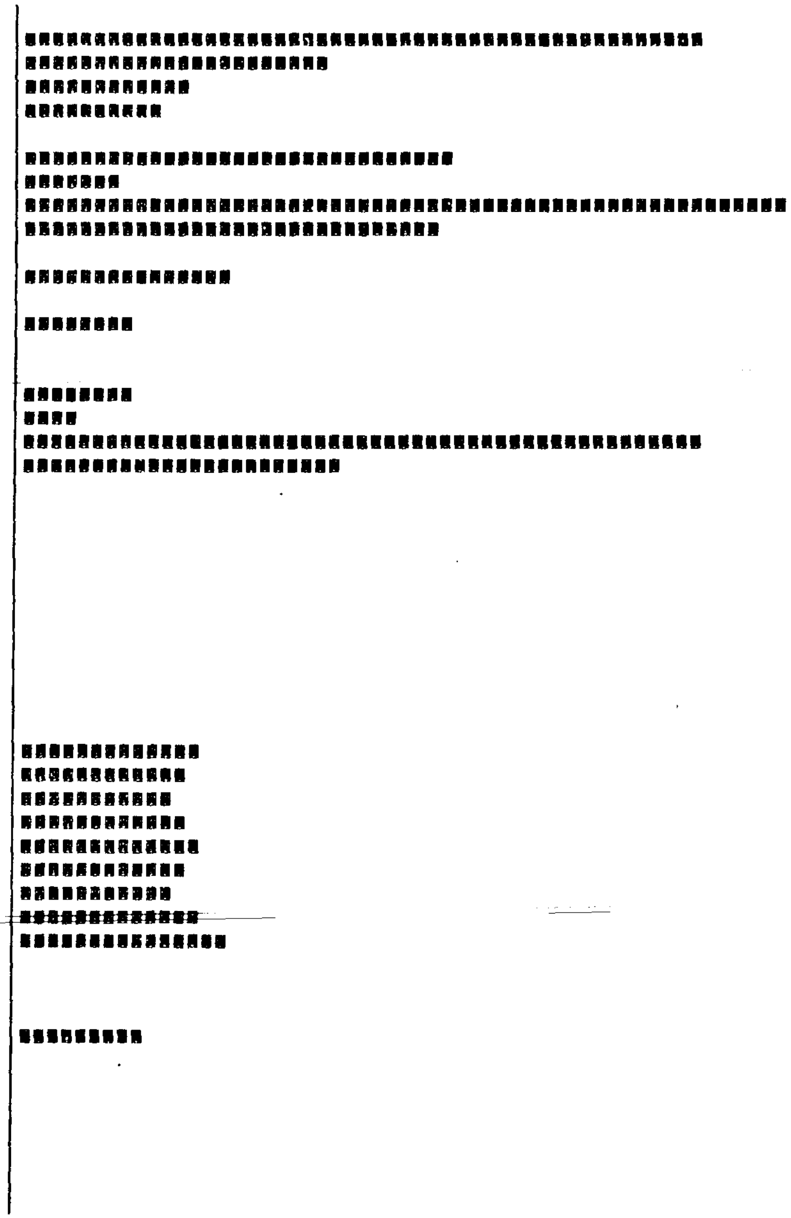


AIR CONTENT STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF STDAIR



CODE	DIST	STDAIR
A	2	2.5
	3	1.1
	4	0.6
	5	0.5
	7	0.0
	8	1.6
	58	0.4
	61	2.8
	62	1.5
A (MINOR)	2	0.7
	3	0.0
	4	0.4
	5	0.0
	7	0.0
	8	0.4
	58	0.2
	61	2.5
	62	1.2
A(M)	2	0.0
	3	0.0
	4	0.0
	5	0.0
	7	0.0
	8	0.0
	58	0.0
	61	0.0
	62	0.0
AA	2	0.6
	3	0.6
	4	0.6
	5	0.6
	7	0.7
	8	0.6
	58	0.5
	61	0.6
	62	0.8
AA(M)	2	0.0
	3	0.0
	4	0.4
	5	0.0
	7	0.0
	8	0.0
	58	0.0
	61	0.0
	62	0.0

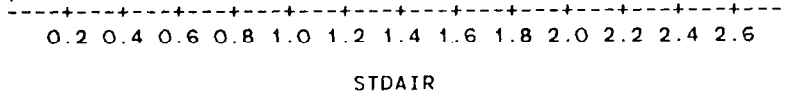
AIR CONTENT STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF STDAIR

CODE	DIST	DISTRICT	STDAIR
R	2		0.0
	3		0.0
	4		0.0
	5		0.0
	7		0.0
	8		0.0
	58		0.0
	61		0.0
	62		0.0
S	2		0.0
	3		0.0
	4	■■■■■■■■■	0.4
	5		0.0
	7		0.0
	8		0.0
	58		0.0
	61		0.0
	62		0.0



AIR CONTENT STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF CVAIR

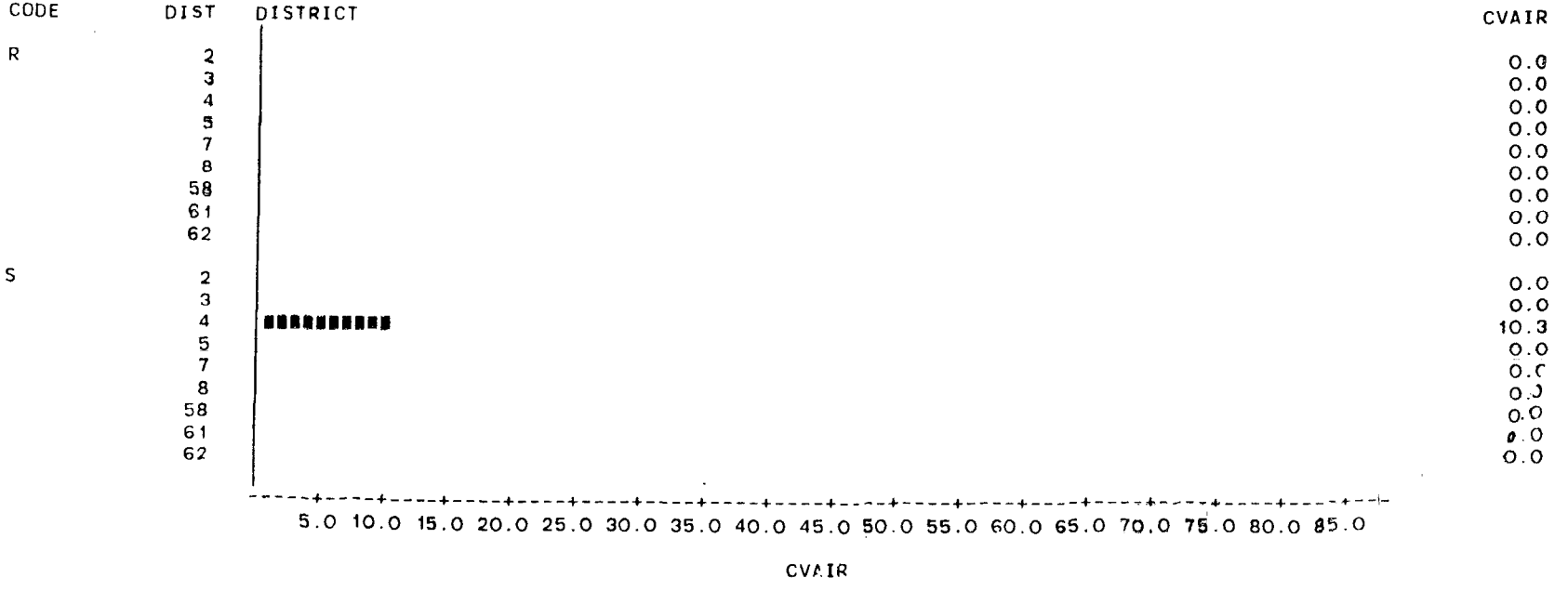
CODE	DIST	CVAIR
A	2	88.4
	3	23.3
	4	14.2
	5	10.9
	7	0.0
	8	34.8
	58	8.3
	61	87.0
	62	33.9
A (MINOR)	2	15.4
	3	0.0
	4	9.5
	5	0.0
	7	0.0
	8	10.4
	58	4.5
	61	75.0
	62	23.8
A(M)	2	0.0
	3	0.0
	4	0.0
	5	0.0
	7	0.0
	8	0.0
	58	0.0
	61	0.0
	62	0.0
AA	2	13.6
	3	13.1
	4	11.9
	5	12.4
	7	13.4
	8	12.9
	58	11.4
	61	13.8
	62	15.6
AA(M)	2	0.0
	3	0.0
	4	8.7
	5	0.0
	7	0.0
	8	0.0
	58	0.0
	61	0.0
	62	0.0

AIR CONTENT STATISTICS FOR STRUCTURAL CONCRETE FOR 1985

BY CLASS OF CONCRETE

FOR THE DISTRICTS

BAR CHART OF CVAIR



SOURCE=C203

CLASS	N	AVG	STD	CV
A	318	4744	613	12.92
AA	166	4805	463	9.63

SOURCE=C207

CLASS	N	AVG	STD	CV
A	491	4737	576	12.15
AA	148	5014	475	9.46
AM	6	4582	245	5.34

SOURCE=C213

CLASS	N	AVG	STD	CV
A	940	4843	528	10.90
AA	182	4778	708	14.81

SOURCE=C214

CLASS	N	AVG	STD	CV
A	315	4865	581	11.93
AA	78	4555	617	13.54

SOURCE=C215

CLASS	N	AVG	STD	CV
A	83	4566	463	10.13

SOURCE=C216

CLASS	N	AVG	STD	CV
A	24	4832	312	6.46
AA	42	5312	634	11.94

SOURCE=C234

CLASS	N	AVG	STD	CV
AA	3	4887	81	1.65

SOURCE=C237

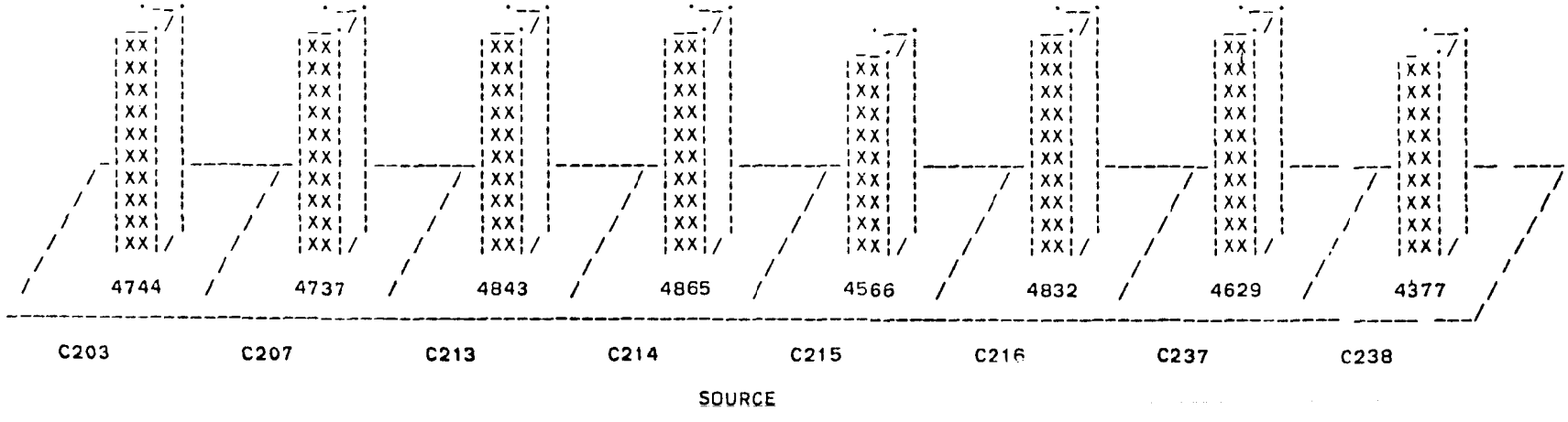
CLASS	N	AVG	STD	CV
A	970	4629	478	10.32
AM	629	4971	431	8.67

SOURCE=C238

CLASS	N	AVG	STD	CV
A	33	4377	341	7.78
AA	191	4882	459	9.41

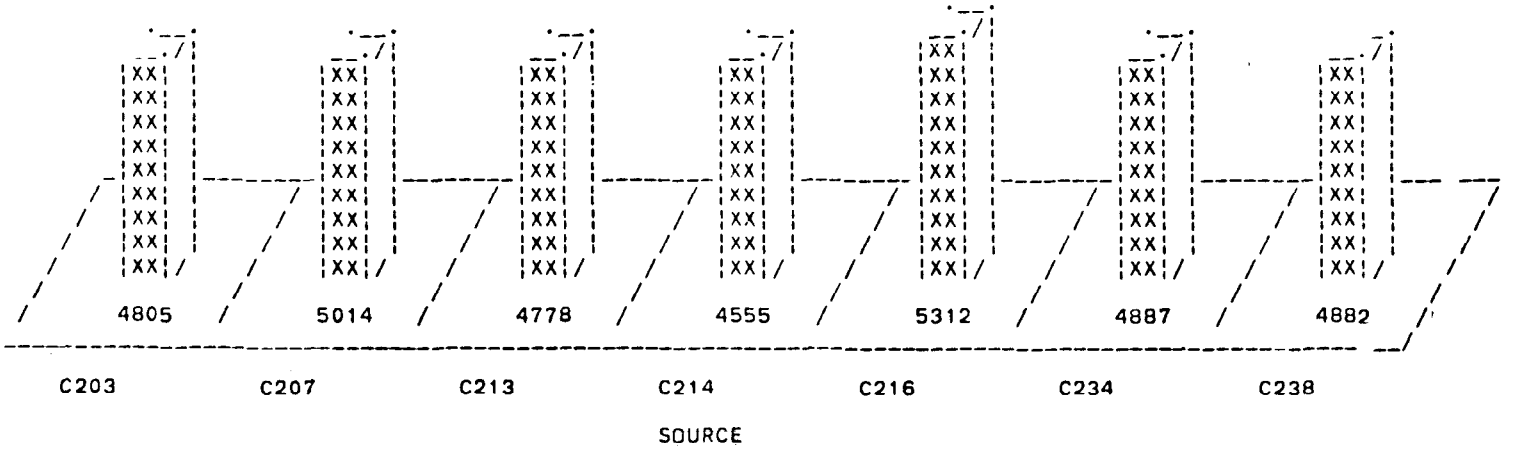
CLASS=A

BLOCK CHART OF AVG

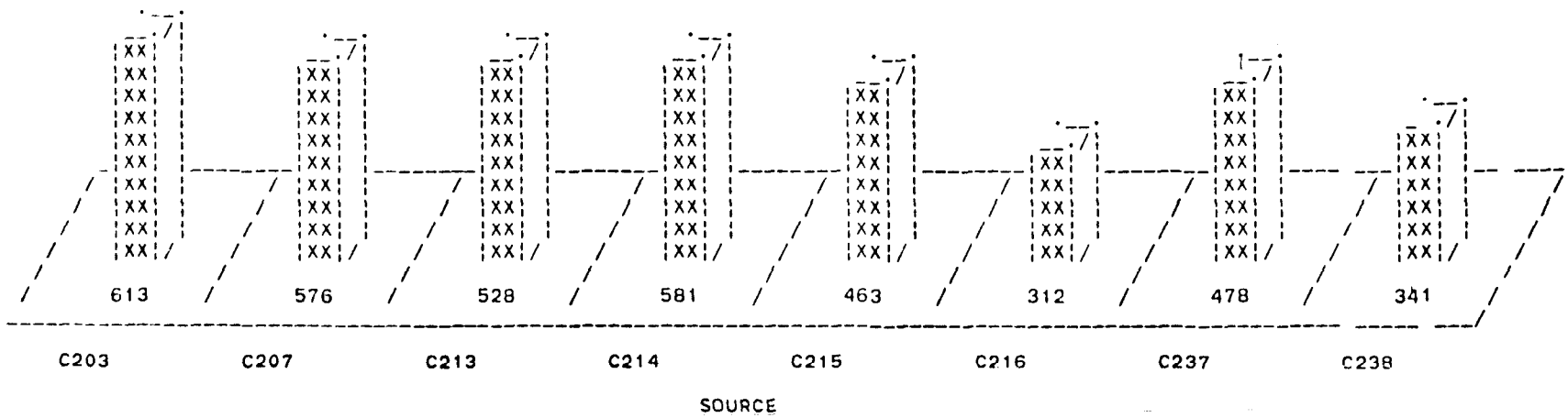


CLASS=AA

BLOCK CHART OF AVG

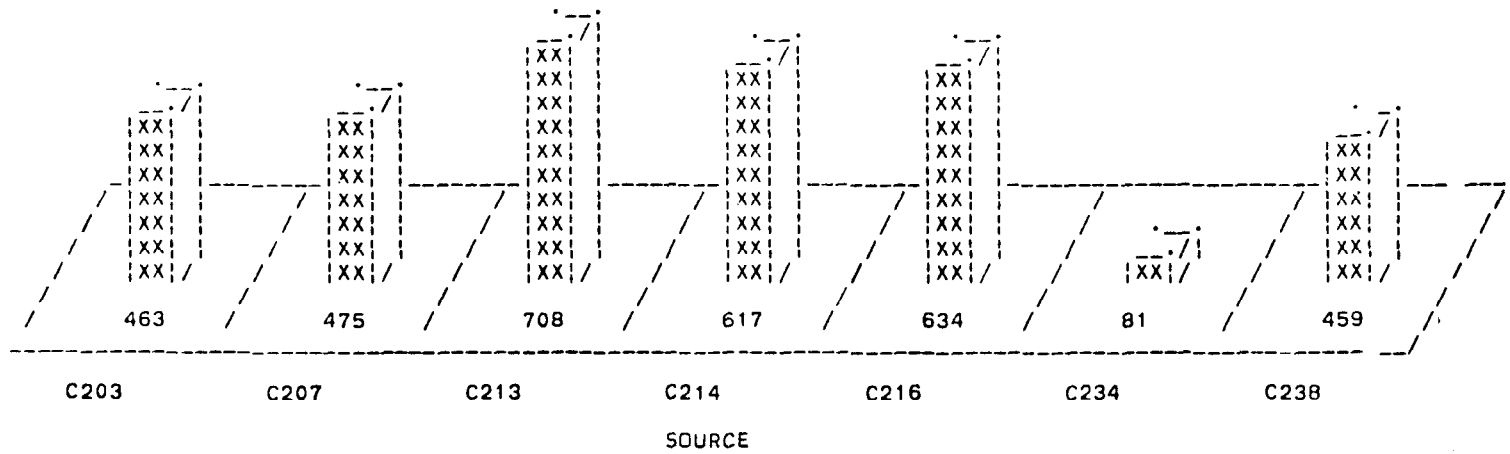


BLOCK CHART OF STD



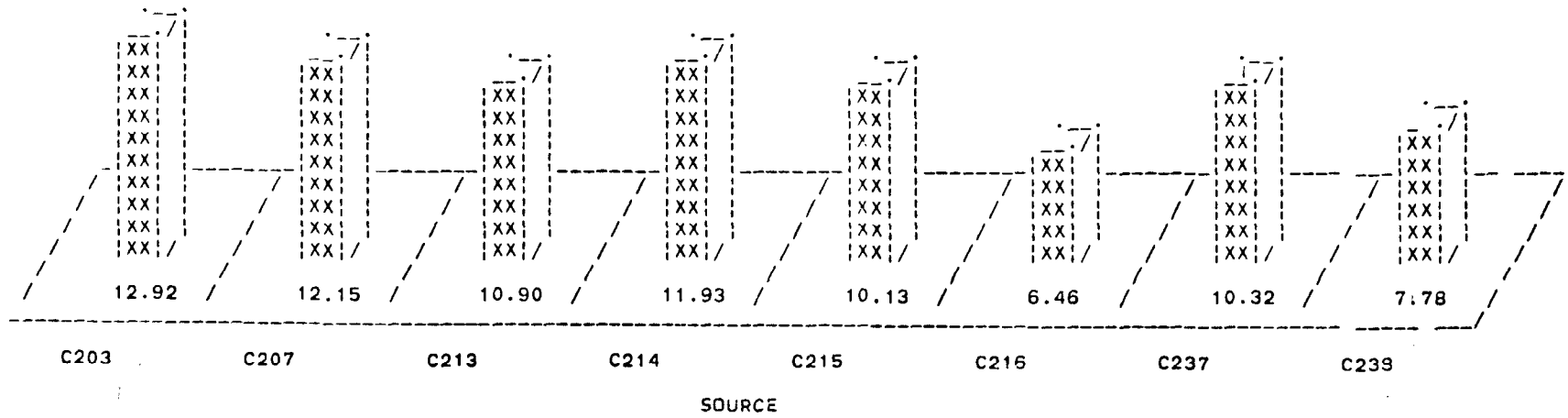
CLASS=AA

BLOCK CHART OF STD



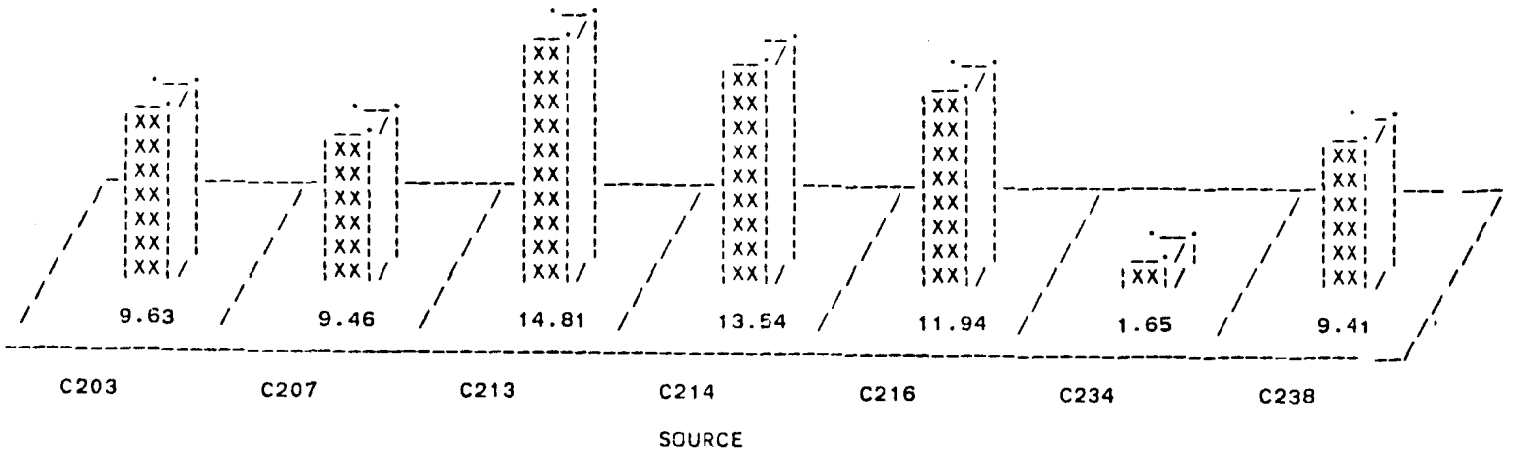
CLASS=A

BLOCK CHART OF CV



CLASS=AA

BLOCK CHART OF CV



SPECIFICATION CONFORMANCE FOR STRUCTURAL CONCRETE

FOR 1985

	PERCENT PAY				
CLASS	100 %	98 %	90 %	50 %	TOTAL
AA	113,396.4 (95.93 %)	4,572.7 (3.87 %)	177.0 (0.15 %)	57.5 (0.05 %)	118,203.6 (100.00 %)
A	138,076.3 (99.81 %)	175.8 (0.13 %)	81.0 (0.06 %)	1.0 (0.01 %)	138,334.1 (100.0 %)

PERCENT PAY	CLASS AA	CLASS A
100 %	4200 & Above	3800 & Above
98 %	3800 - 4199	3400 - 3799
90 %	3200 - 3799	3000 - 3399
50 %	Below 3200	Below 3000

SPECIFICATION CONFORMANCE FOR STRUCTURAL CONCRETE

CLASS A

YEAR	PERCENT PAY 100 %	98 %	90 %	50 %	TOTAL
1978	7,945.5 (88.20 %)	808.7 (8.98 %)	254.1 (2.82 %)		9,008.3 (100.00 %)
1979	51,500.2 (86.63 %)	5,903.4 (9.93 %)	1,688.0 (2.84 %)	354.5 (0.60 %)	59,466.1 (100.00 %)
1980	38,871.2 (92.90 %)	1,887.3 (4.51 %)	878.6 (2.10 %)	203.0 (0.49 %)	41,840.1 (100.00 %)
1981	59,615.2 (96.18 %)	2,078.2 (3.35 %)	249.8 (0.40 %)	40.0 (0.06 %)	61,983.2 (100.00 %)
1982	55,422.2 (94.54 %)	2,716.3 (4.63 %)	466.5 (0 %)	16.4 (0.03 %)	58,621.4 (100.00 %)
1983	99,500.8 (97.33 %)	2,046.0 (2.00 %)	630.4 (0.62 %)	53.0 (0.05 %)	102,230.2 (100.00 %)
1984	86,349.3 (98.14 %)	1,434.7 (1.63 %)	170.0 (0.19 %)	30.0 (0.03 %)	87,984.0 (100.00 %)

SPECIFICATION CONFORMANCE FOR STRUCTURAL CONCRETE

CLASS AA

YEAR	PERCENT PAY 100 %	98 %	90 %	50 %	TOTAL
1978	22,000.2 (93.20 %)	1,229.1 (5.21 %)	340.5 (1.44 %)	35.0 (0.15 %)	23,604.8 (100.00 %)
1979	29,424.0 (94.69 %)	1,317.8 (4.24 %)	282.6 (0.91 %)	50.0 (0.16 %)	31,061.9 (100.00 %)
1980	65,114.7 (95.71 %)	2,053.9 (3.02 %)	537.8 (0.79 %)	324.1 (0.46 %)	67,990.5 (100.00 %)
1981	63,726.7 (98.30 %)	923.0 (.42 %)	54.4 (0.24 %)	25.0 (0.04 %)	60,655.7 (100.00 %)
1982	93,931.7 (98.87 %)	962.0 (1.02 %)	30.7 (0.03 %)	66.0 (0.07 %)	99,999.9 (100.00 %)
1983	73,418.0 (99.02 %)	693.6 (0.94 %)	17.7 (0.02 %)	14.5 (0.02 %)	74,143.8 (100.00 %)
1984	92,191.8 (99.34 %)	503.5 (0.54 %)	87.8 (0.09 %)	23.5 (0.03 %)	92,806.6 (100.00 %)