FIELD USE OF NUCLEAR METHODS FOR QUALITY CONTROL OF SOIL COMPACTION

US 127 Relocation between Columbia Road and I 96
(Projects I 33084A, C 21 and F 33035B, C 1)

Research Laboratory Division
Office of Testing and Research
Research Project R-61 E-22
HPR Control Section 86540

Michigan State Highway Department
John C. Mackie, Commissioner
Lansing, November 1964

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Use of the nuclear gage for the control of compaction on the US 127 Relocation between Columbia Road and I 96 (I 33084A, C 21 and F 33035B, C1) has been approved by the Department's Planning and Research Policy Committee. The purpose of this work is to determine suitability of the nuclear method for control of subgrade, subbase, and base course compaction in normal highway construction operations.

Previous field work with the nuclear gage has been concerned with attempts to compare nuclear values with those obtained by the conventional Rainhart methods. Because the two instruments measure different volumes of soil during test, and because errors in both methods were likely to be compounded, a poor correlation between the two methods was often attained. Consequently, field operations did not encourage confidence in the nuclear method.

In order to evaluate the nuclear gage's usefulness, it should be used directly in the field as the primary density control without comparing individual tests with conventional methods. Furthermore, the full potential of the nuclear method can best be realized if it is used in conjunction with a statistical approach to density control. In such procedures full advantage can be taken of the speed and simplicity of the nuclear method, which allow quality control methods to be used for determining acceptable compaction. Such methods fit into normal construction operations, require no additional personnel, and propose no change in the end point requirements for proper density control. The Rainhart method will be used as a general check of compaction with a minimum number of tests equal to the number required for record testing.

The Research Laboratory will train density inspectors in use of nuclear equipment, establish proper field procedures for use of the nuclear gage following quality control guidelines to obtain optimum results, and maintain the equipment.

General Procedure

1. Determine maximum density and optimum moisture values at specified intervals by either the one-point Proctor or the Michigan Sand Cone method.

2. Using the maximum dry density and existing field moisture values, compute the desired wet density and determine nuclear count rate equivalent for 95 or 100 percent of this value, whichever is required.

3. Using one 2-minute nuclear count per test, measure density of selected locations at an approximate average rate of one test per 250 ft of roadway. Guidelines for selection of test areas are listed below.

4. If a reading shows density to be below the required minimum, take two more 2-minute readings of both density and moisture content in the immediate proximity of the original test. The moisture content of the soil should be compared to the optimum value. If near optimum moisture and if additional rolling does not increase density, a one-point Proctor test should be conducted as a means of determining a change in material.

5. After several density tests have been conducted, Research Laboratory personnel will provide a control chart for use on the project similar to the one shown in Fig. 1. This chart will provide both high and low limits for acceptable density values. If the density values exceed the maximum control limits, a possible change in material is indicated and should be investigated.

6. Field data will be entered on the form shown in Fig. 2.

Selection of Density Test Areas

1. Subgrade - Test areas will be selected by project engineer or his representative.

2. Subbase - a) where the material is uniform, test areas will be determined by the random test block method.

   b) where the material is non-uniform, test areas will be selected by project engineer or his representative.

3. Selected Subbase - Test areas determined by the random block method.

4. Base Course - Test areas determined by the random block method.

Random Block Method of Selecting Density Test Sites

1. Each roadway will be considered separately.

2. The entire length of the job will be considered as a series of test areas, 2000 ft in length.

3. Each test area will be separated into five test sections each being 400 ft in length as shown in Fig. 3.

4. Two 400 ft test sections will be selected at random for testing from each 2000-ft test length.

5. Each 400-ft test section will be divided into eight blocks, each being 100 ft in length as shown in Fig. 4.

6. Four 100-ft test blocks within each section will be selected at random for testing.

7. One 2-minute nuclear density reading will be taken in each block.

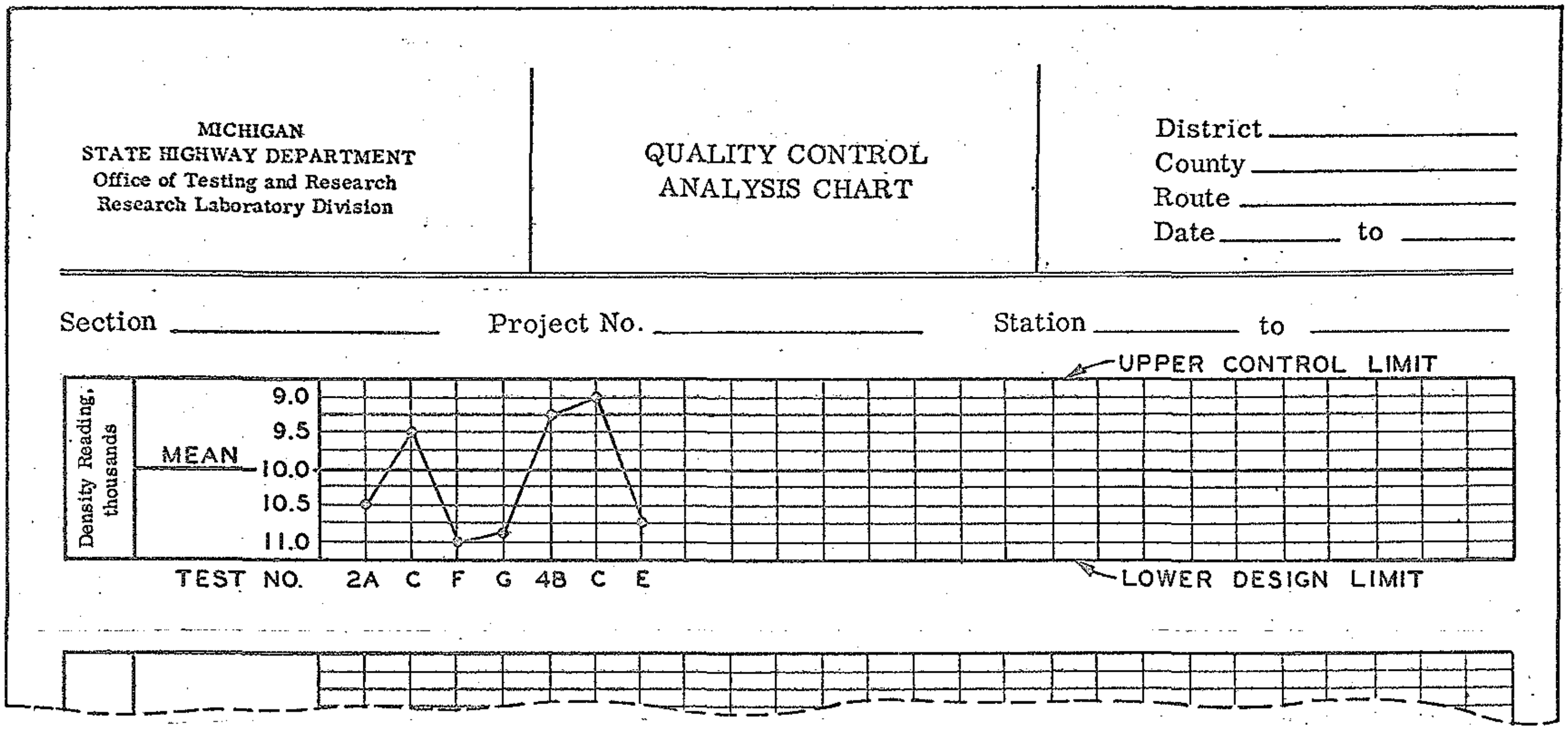

Figure 1. Typical density control entry.

MICHIGAN
STATE HIGHWAY DEPARTMENT
Office of Testing and Research
Research Laboratory Division

GENERAL INSPECTION FORM

Control Section ____________

Date ________ Inspector ____________ Gage No. ________ Project Engineer ____________

Test No.		Standards		Wet Density		Moisture		Dry Density			Location of Test				
Original	Recheck	Density	Moisture	Reading	Wet, Density, pcf	Reading	m %	Dry Density, pcf	Max. Dry Density	Per-cent of Com-paction	Station	Distance from ℄ Left	Distance from ℄ Right	Depth Below Plan Grade	Item of Work

Density Requirements

	Percent Density	Depth, in.	Item of Work
Original Ground-Embankment Areas . . .			
Road - Where fill is 5 ft or less	90	9	OG
Structures - within toe of slopes. . . . 50 ft ahead and behind footings . . .	90	9	OG
Cut Areas			
Cuts requiring Sand Subbase	95	9	CS
Cuts not requiring Sand Subbase	95	18	CN

Embankments	Percent Density	Item of Work
Regular	95	E
Abutments with Piling	95	AP
Abutments without Piling - within toe of slopes and 50 ft ahead and behind footing	100	AN

	Percent Density	Item of Work
Backfill for Structures, Culverts, and Sewer tile . .	95	B
Sand Subbase	95	S
Selected Subbase	95	SS
Aggregate Base Course	100	AB
Aggregate Base Course Widening	100	AB
Aggregate Base Course - Bituminous Shoulders . . .	100	AC
Shoulders - Class AA (Supp. 6.27.10)	100	SAA
Shoulders Class A and B	95	SA

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Remarks ____________

Figure 2. General inspection form for nuclear gage data.

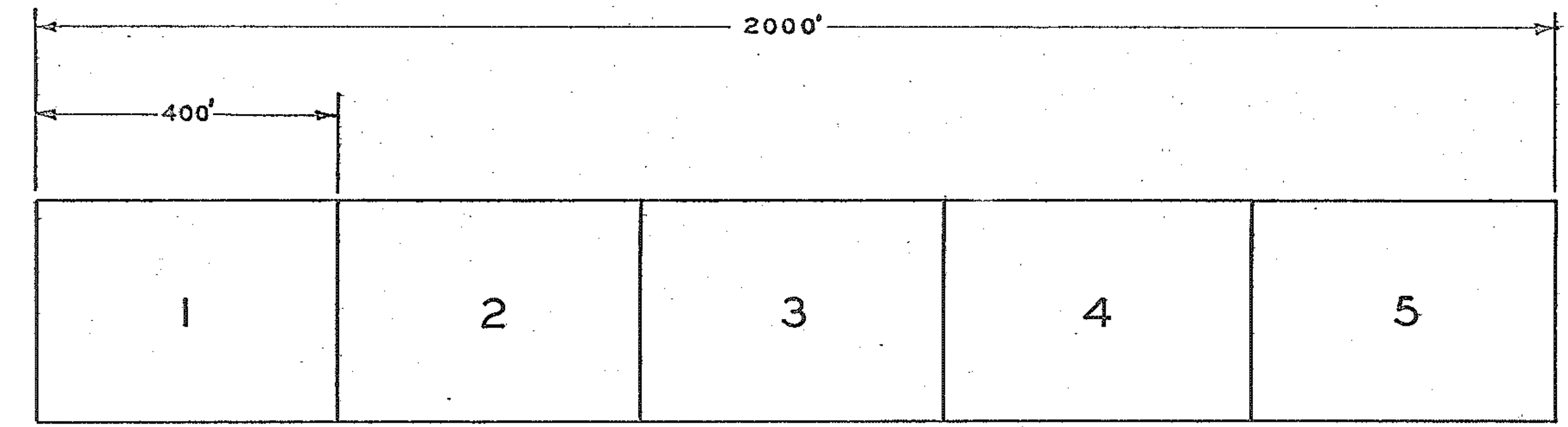

Figure 3. Division of test area into test sections.

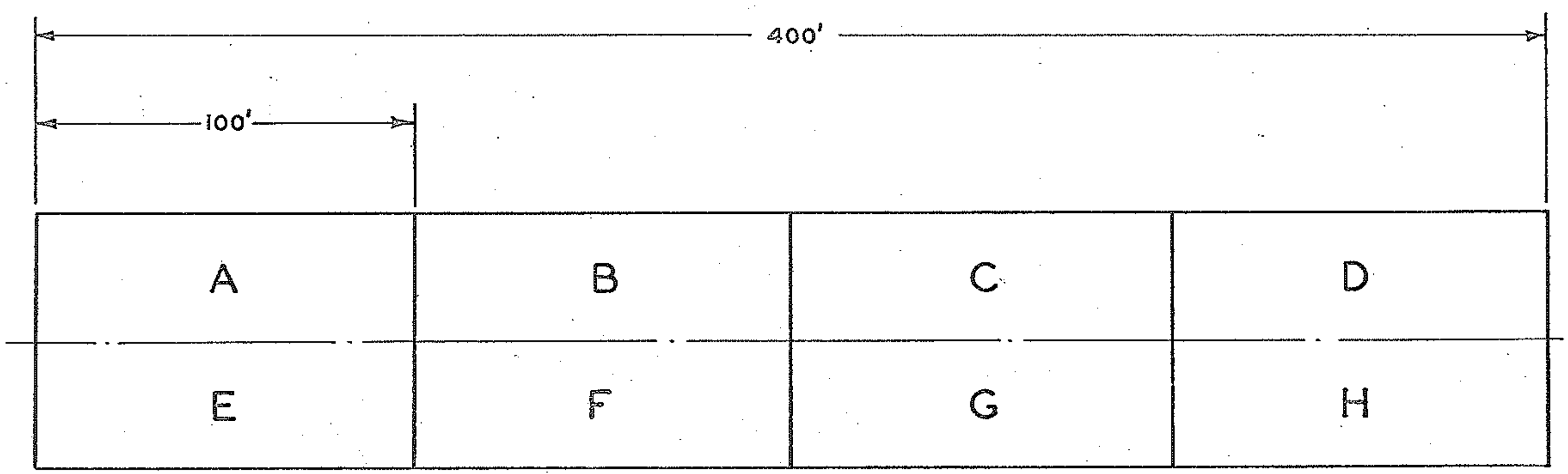

Figure 4. Division of test section into blocks.