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16. ABSTRACT
The depth that a nuclear gage is below the surface of surrounding soil and the proximity of a concrete structure to the gage affects the nuclear gage moisture determinations. This interim report is limited to the findings made with a Troxler Gage Scaler Model No. 650, Probe Model SCM-257-1967 and a Portaprobe Gage Model No. A-1967 on Structure Backfill (a gravely sand) representative of material from Road 08-SBd-15, 31, 138, Contract No. 08-049114. The testing was done after the material was compacted in a test pit 39" wide x 42" long by 12" deep, with and without a concrete slab along one side of the hole, and at two moisture contents, i.e., (1) slightly above and (2) slightly below optimum. Initial gage readings were recorded when the horizontal clearance was one inch and the depth of probe, below the surface, was increased in one-inch increments to a depth of six inches. This procedure was repeated with horizontal clearances of two and three inches. Samples were taken for oven-dry moisture determinations to compare with each set of nuclear gage readings. The test data can be used to determine a correction factor to be applied to nuclear moisture determinations made with a similar Troxler gage or a similar Portaprobe gage if the field conditions are similar to the test conditions for this research project.

17. KEYWORDS
Troxler, Portaprobe, nuclear moisture determinations, structure backfill, concrete structures, test results, soils

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HIGHWAY RESEARCH REPORT

EFFECT OF FIELD VARIABLES ON NUCLEAR GAGE MOISTURE DETERMINATIONS

INTERIM REPORT

69-14

March, 1969

STATE OF CALIFORNIA

BUSINESS & TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

RESEARCH REPORT

NO. M & R 642978-1

STATE OF CALIFORNIA—TRANSPORTATION AGENCY

RONALD REAGAN, *Governor*

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT
5900 FOLSOM BLVD., SACRAMENTO 95819

March 1969

Interim Report
M&R No. 642978

Mr. J. A. Legarra
State Highway Engineer

Dear Sir:

Submitted herewith is a research report titled:

EFFECT OF FIELD VARIABLES ON NUCLEAR GAGE MOISTURE DETERMINATIONS

TRAVIS SMITH
Principal Investigator

ALBIN D. HIRSCH and WILLIAM F. KLEIMAN
Co-Investigators

Assisted by

B. Zeiler
B. Lister

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

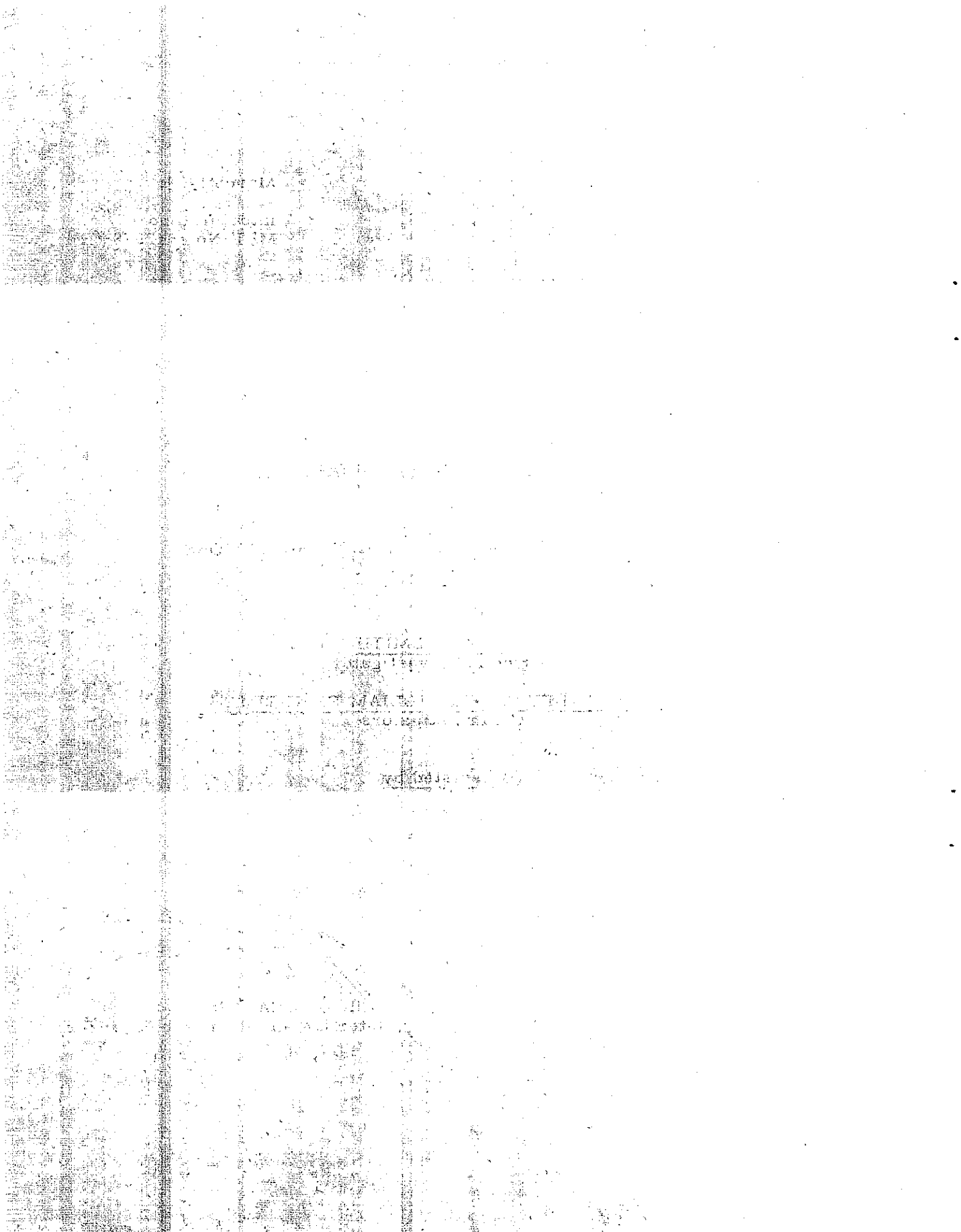


TABLE OF CONTENTS

REFERENCE: Smith, Travis, Hirsch, Albin D., Kleiman, William F.

"Effect of Field Variables on Nuclear Gage Moisture Determinations," State of California, Department of Public Works, Division of Highways, Materials and Research Department. Research Report 642978-1, March, 1969.

ABSTRACT: The depth that a nuclear gage is below the surface of surrounding soil and the proximity of a concrete structure to the gage affects the nuclear gage moisture determinations. This interim report is limited to the findings made with a Troxler Gage Scaler Model No. 650, Probe Model SCM-257-1967 and a Portaprobe Gage Model No. A-1967 on Structure Backfill (a gravelly sand) representative of material from Road 08-SBd-15, 31, 138, Contract No. 08-049114. The testing was done after the material was compacted in a test pit 39" wide x 42" long by 12" deep, with and without a concrete slab along one side of the hole, and at two moisture contents, i.e., (1) slightly above and (2) slightly below optimum. Initial gage readings were recorded when the horizontal clearance was one inch and the depth of probe, below the surface, was increased in one-inch increments to a depth of six inches. This procedure was repeated with horizontal clearances of two and three inches. Samples were taken for oven-dry moisture determinations to compare with each set of nuclear gage readings. The test data can be used to determine a correction factor to be applied to nuclear moisture determinations made with a similar Troxler gage or a similar Portaprobe gage if the field conditions are similar to the test conditions for this research project.

KEY WORDS: Troxler, Portaprobe, nuclear moisture determinations, structure backfill, concrete structures, test results, soils.

INTRODUCTION

This project was initiated as a result of difficulties experienced by District 08 on Contract No. 08-049114 on Road 08-SBd-15, 31, 138 (Cajon Pass Job) when determining moisture and densities with a Troxler nuclear gage on structure backfill containing approximately 15% plus 3/4" fragments.

This interim report is limited to determining the effect of a concrete structure, within three inches of a nuclear gage, and the effect of the position of the gage with reference to horizontal clearance (within three inches) of structure backfill, and depth of gage below the surface (down to six inches) of structure backfill on moisture determinations made with a Troxler gage and a Portaprobe gage.

The work described herein is part of a larger research project which will be described in some detail at the end of this report.

OBJECTIVE

The objective of this portion of the overall research project is to determine if a correction factor can be applied to the moisture determinations made with nuclear gages.

We believe that the data presented in this report can be used to determine a correction factor to be applied to moisture determinations made with a Troxler gage and a Portaprobe gage if the field conditions are similar to the test conditions for this research project.

CONCLUSIONS

1. The Portaprobe nuclear gage moisture content determinations are approximately 10-50% greater than the Troxler gage determinations depending on the particular test conditions (presence or absence of concrete slab, relatively dry or wet structure backfill, depth of gage and horizontal clearance around the gage).

2. There is a relatively uniform increase in the difference between nuclear moisture determinations and the oven-dry moistures as the depth of either gage is increased below the surface of the structure backfill.

3. There is a greater difference between oven-dry moisture content and nuclear moisture content when the material is relatively dry than when the material is relatively wet.

4. With the concrete slab present, nuclear moisture contents determined with either gage are markedly increased when the horizontal clearance is less than three inches. This is evident even at depths of only one or two inches and applies both to the "wet" and "dry" conditions.

Without the slab, and at depths of one or two inches, the nuclear gage moisture determinations agree with the oven dry moisture determinations. At greater depths the readings are affected more by the depth of gage than by the horizontal clearance.

5. Test data from both gages show a general decrease in the difference between nuclear moisture determinations and oven-dry moisture determinations as the horizontal clearance is increased from one to three inches.

6. Correction factors for both gages have been developed which can be applied to nuclear moisture determinations if the field conditions are similar to the test conditions for this research project.

RECOMMENDATIONS

The conclusions in this report cannot be applied to all nuclear gages or to all materials throughout the state of California. The data can serve as a model for a minor research project, if it is necessary to make corrections in moisture determinations when the gage readings on a construction project do not fit a valid calibration curve.

Due to inconsistencies or variations between gages it must be remembered that the calibration curves furnished with each gage must be checked with the actual project materials and with the particular gage which will be used to test the material. This is so stated in Part C, Calibration, of Test Method No. Calif. 231.

TESTING DETAILS

Field conditions were somewhat simulated for this study. The material used on this project was from District 08 (Cajon Pass Job) Contract No. 08-049114 on Road 08-SBd-15, 31, 138. A large bulk sample of structure backfill (gravelly sand), approximately 4000 lbs., was obtained from two locations on the contract and all of the material was from the same Cajon Wash source.

For this nuclear-moisture study, the material was scalped on the 1-1/2" sieve for compaction in a 12" deep aluminum mold or a 12" deep hole in the ground. Compaction was done with a 10-lb. hammer equipped with a 4-inch square foot and an 18" drop. The specimens were compacted in four 3-inch lifts. Nuclear counts were obtained with a Troxler gage Scaler Model 650 and Probe Model SCM-257-1967 and a Portaprobe gage Model A-1967.

The moisture calibration curves were established by compacting our specimens at four different moisture contents, ranging between 4.7 and 8.7 lbs. per cu. ft., in an aluminum mold with inside dimensions of 18" square by 12" deep and recording nuclear moisture counts on each of our specimens. Several additional points were obtained in the field when the material was compacted in the test pit to assure valid calibration curves. The calibration curves, oven dry moisture content vs. count ratio*, are shown on Figure 1.

Field research of this San Bernardino County material was done in a test pit 39" wide by 42" long x 12" deep dug in the native soil in Sacramento. Two concrete slabs, 35" x 48", with a combined thickness of approximately seven inches, were placed vertically along one side of the hole and the remainder of the hole was filled with structure backfill. See Fig. 2. The testing was performed at densities similar to those obtained on the actual contract. Duplicate testing was done at two different moisture contents, i.e., (1) slightly above and (2) slightly below optimum. The moisture contents ranged from approximately 2-7%.

*Count ratio = $\frac{\text{Test Count}}{\text{Standard Count}}$

The initial testing was done with the structure backfill relatively dry and a horizontal clearance of one inch. The depth of the probe, below the surface, was increased in one-inch increments to a maximum depth of six inches. This testing was repeated with horizontal clearances of two and three inches. The whole procedure was repeated with the structure backfill relatively wet.

The second phase of testing consisted of duplicating the above procedure, but without the presence of the concrete slab.

ANALYSIS

It has been previously concluded that a correction should be made on the moisture contents when the Troxler probe is less than 8" from a concrete slab. This was mentioned in our memorandum to District 08 Engineer Mr. C. V. Kane, dated June 18, 1968, which was given statewide distribution with memorandum dated September 10, 1968. This data and Portaprobe data will be included in the final report for this project.

The interim report includes data applicable to nuclear moisture determinations made when the probe is within three inches of a concrete slab.

Figures 3 through 6 show the Troxler data and Figures 15 through 18 show the Portaprobe data plotted with depth of probe as the abscissa and moisture content, in pounds per cubic foot, as the ordinate. Figures 8 through 11, and 20 through 23, show the same data plotted with horizontal clearance as the abscissa and moisture content as the ordinate.

It is our opinion that the variation of the individual points from a straight line as shown in these data, is to be expected when determining moisture contents with either the nuclear gage or with the oven-dry method.

Figures 7 and 19 show the average of all test results and indicates that:

1. If the material is relatively dry and the concrete slab is absent the nuclear readings are in agreement with the oven-dry determinations when the gage is two inches or less below the surface. This is evident with the Portaprobe gage as well as the Troxler gage.

2. If the material is relatively dry and the concrete slab is within three inches of the gage, the Troxler gage indicates moisture contents of four to eight pounds per cubic foot higher than the moisture contents determined by the oven-dry method. This increase with depth from zero to six inches is on an approximate linear relationship. The Portaprobe gage shows higher moisture contents of 6-14 pounds per cubic foot under the same test conditions.

The same relationship exists if the material is relatively wet but the data is approximately two to four pounds per cubic foot higher on the moisture content scale.

It is quite difficult to study the data and assign equal importance to each individual point on the figures. For this reason, average values have been plotted as shown on Figures 7, 12, 13 and 14 for the Troxler gage and on Figures ~~12,~~ 19, 24, 25 and 26 for the Portaprobe gage.

The individual points on Figures 8 through 11 for the Troxler gage and on Figures 20 through 23 for the Portaprobe gage show reversing curves and varying differences between nuclear and oven-dry moisture determinations. It can be assumed that if the moisture was uniformly distributed throughout the sample, the nuclear readings would show a linear decrease in moisture content as the horizontal clearance is increased from one inch to three inches. In order to show this trend, the data were analyzed through several stages of averaging and adjusting moisture contents.

The data were separated into two categories: (1) averaging the surface, one-inch depth, and two-inch depth readings; and (2) averaging the four-inch, five-inch, and six-inch depth readings. See Figure 12 for the Troxler data and Figure 24 for the Portaprobe data. These reversing curves and various differences still do not lend themselves to a clear analysis of the data.

The oven-dry moistures were adjusted by moving the data for the one-inch and three-inch horizontal clearance conditions up or down to agree with the data for the two-inch horizontal clearance condition. The nuclear data for the same conditions were adjusted a similar amount. Figures 13 and 25 show the oven-dry moisture plotted as a straight horizontal line to compare with the adjusted nuclear moisture values for the Troxler gage and the Portaprobe gage, respectively. This is further clarified on Figures 14 and 26 where a zero base line is assumed for the oven-dry moistures and the plotted values of the nuclear readings are the differences between the oven-dry and the nuclear determinations.

ADDITIONAL WORK

Large bulk samples, approximately 2500 to 3500 pounds, have been obtained from other current construction jobs as follows:

1. Road 02-Tri-3-67.8/73.5	Cont. No. 02-044914
2. Road 02-Sis-5-54.2/58.5	Cont. No. 02-045734
3. Road 02-DN-101-4.7/6.1	Cont. No. 01-043954
4. Road 10-Sol-80-8.0/12.5	Cont. No. 10-081104

Field work consisting of density determination by sand volume method and moisture content by oven-dry method and density and moisture determinations with the same two nuclear gages (Troxler and Portaprobe) has been done on the Trinity, Siskiyou and Del Norte Counties projects. Six sites, covering an area of approximately 30' x 150' of rocky embankment material were tested on each project. Sufficient material was obtained from each site to determine test maximum density (impact test) according to Test Method No. Calif. 216.

Laboratory work has consisted of compacting the bulk sample material in an aluminum mold 18" square by 12" deep. Four specimens, with varying percentages of +3/4" fragments, i.e., 0%, 10%, 20% and 30%, of the samples from the projects where the field work has been done, have been compacted and tested for density by sand volume method, moisture by oven-dry method and density and moisture determinations with the two nuclear gages. Test maximum density has been determined for each of the specimens.

Similar laboratory work has been done on the sample from the Solano County project, which is structure backfill from the Red Rock Quarry near Vallejo.

A considerable amount of plotting and analysis of data has been done and the one tentative conclusion is:

The percentage of +3/4" fragments, in the range tested, 0-35%, does not affect the density or moisture determinations made with the nuclear gages.

The results of all the work done on the materials from Del Norte, Siskiyou, Trinity, San Bernardino and Solano Counties will be presented in the final report for this research project.

REFERENCES

1. Beaton, John L., "Troxler Gage-Moisture Study, E.A.No. 642978, 08-SBd-15, 31, 138," memorandum to Mr. C. V. Kane - District 08, dated June 18, 1968.

2. Beaton, John L., "Troxler Gage-Moisture Study, E. A. No. 642978, 08-SBd-15, 31, 138," memorandum to each District Engineer dated September 10, 1968.

3. Beaton, John L., "Troxler Gage-Moisture Study, E. A. No. 642978, 08-SBd-15, 31, 138, memorandum to Mr. C. V. Kane-District 08, dated December 4, 1968.

4. Weber, William G., Jr., "Laboratory and Field Evaluation of Nuclear Surface Gages for Determining Soil Moisture and Density," presented at Highway Research Board Meeting, Washington, D.C., January, 1964.

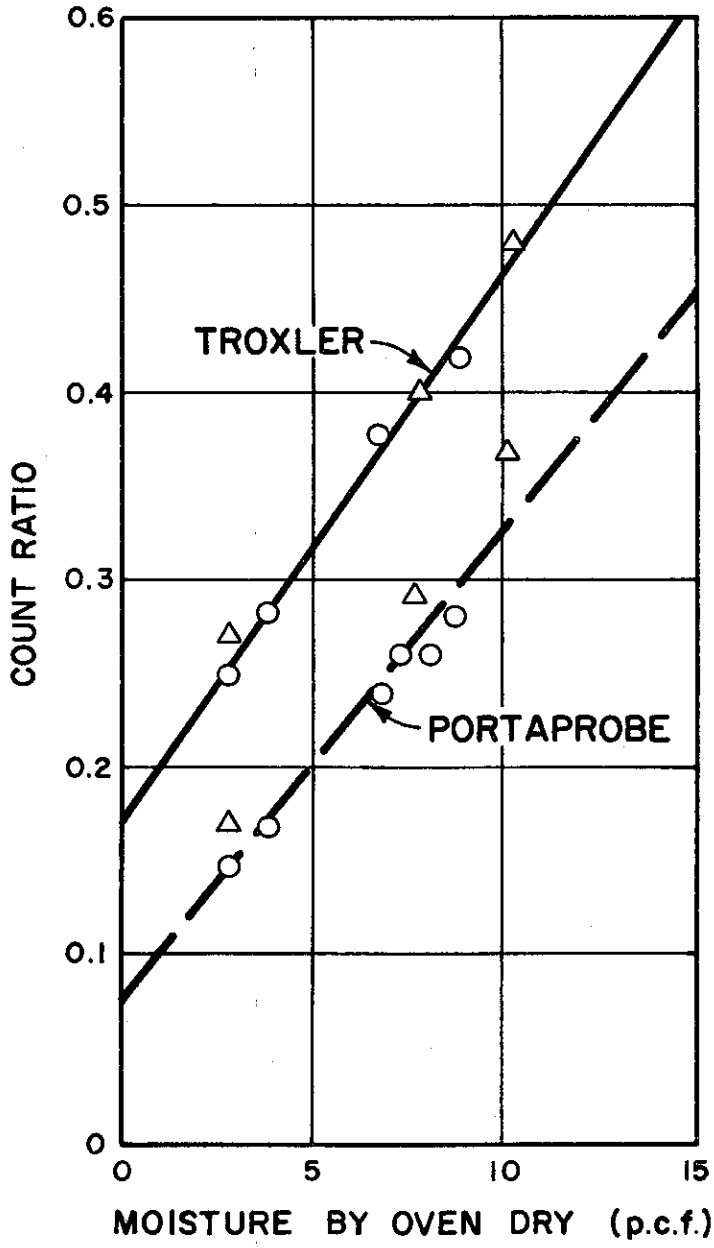
Figure 1

MOISTURE CALIBRATION
STRUCTURE AND BRIDGE BACKFILL
SAN BERNARDINO COUNTY

LEGEND

TROXLER
SCALER NO. 106, MODEL 650
PROBE NO. 114, MODEL SMC-257-1967

PORTAPROBE
GAGE NO. 0010, MODEL A-1967



CURVES CALIBRATED
FROM AL MOLD - ○
AND FIELD DATA - △
JUNE 1968

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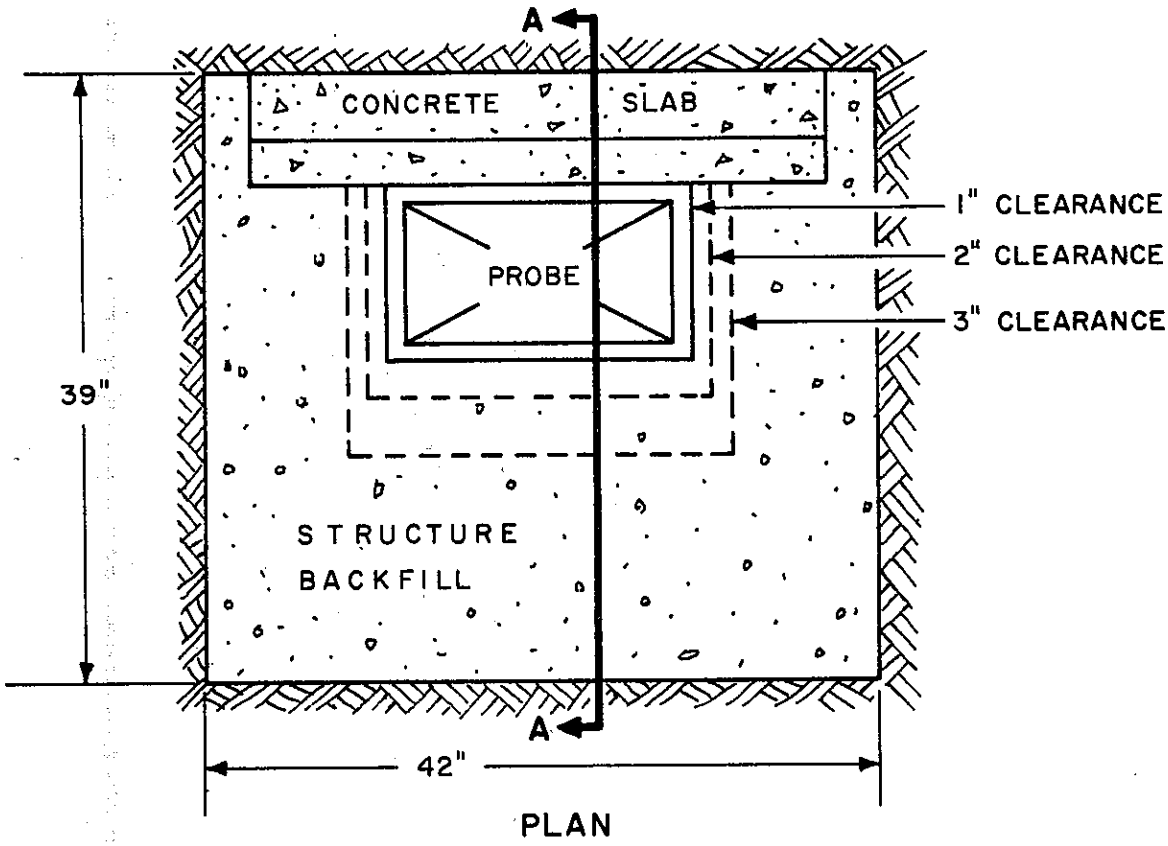
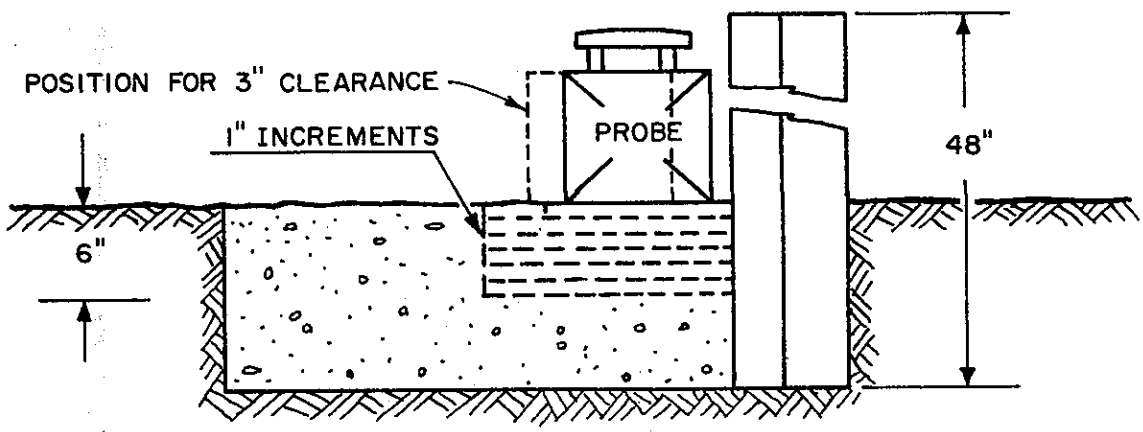
NO M.&R. 642978

Figure 2

CONCRETE SLAB USED IN NUCLEAR GAGE MOISTURE STUDY



PLAN



SECTION A – A

SCALE 1" = 1'

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NO. M&R 642978

Figure 3

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

HORIZONTAL CLEARANCE FROM NUCLEAR PROBE	1"	2"	3"
NUCLEAR MOSTURE CONTENT	○	△	□
OVEN DRY MOISTURE CONTENT	●	▲	■

RELATIVELY DRY BACKFILL WITH
CONCRETE SLAB.

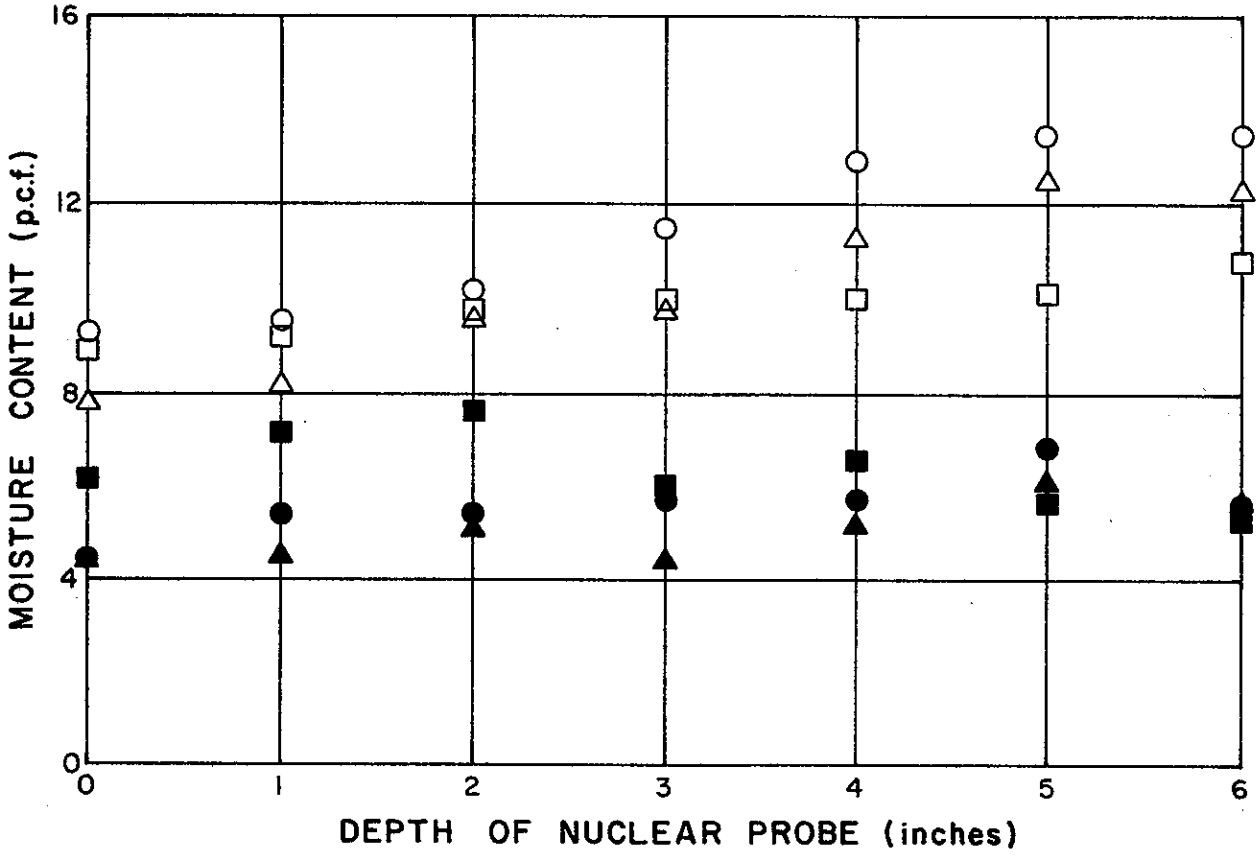

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Figure 4

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

HORIZONTAL CLEARANCE FROM NUCLEAR PROBE	1"	2"	3"
NUCLEAR MOSTURE CONTENT	○	△	□
OVEN DRY MOISTURE CONTENT	●	▲	■

RELATIVELY WET BACKFILL WITH CONCRETE SLAB.

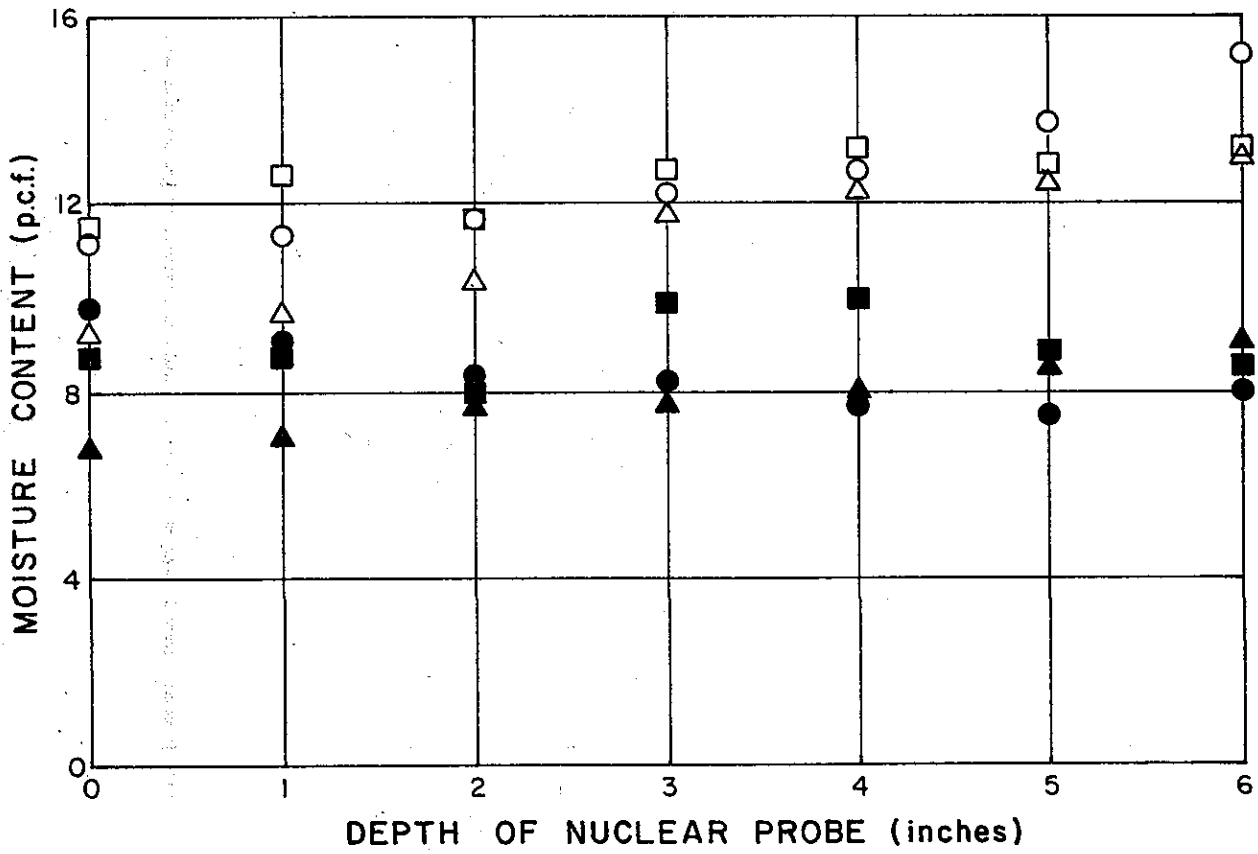

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Figure 5

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

HORIZONTAL CLEARANCE FROM NUCLEAR PROBE	1"	2"	3"
NUCLEAR MOSTURE CONTENT	○	△	□
OVEN DRY MOISTURE CONTENT	●		■

RELATIVELY DRY BACKFILL WITHOUT CONCRETE SLAB.

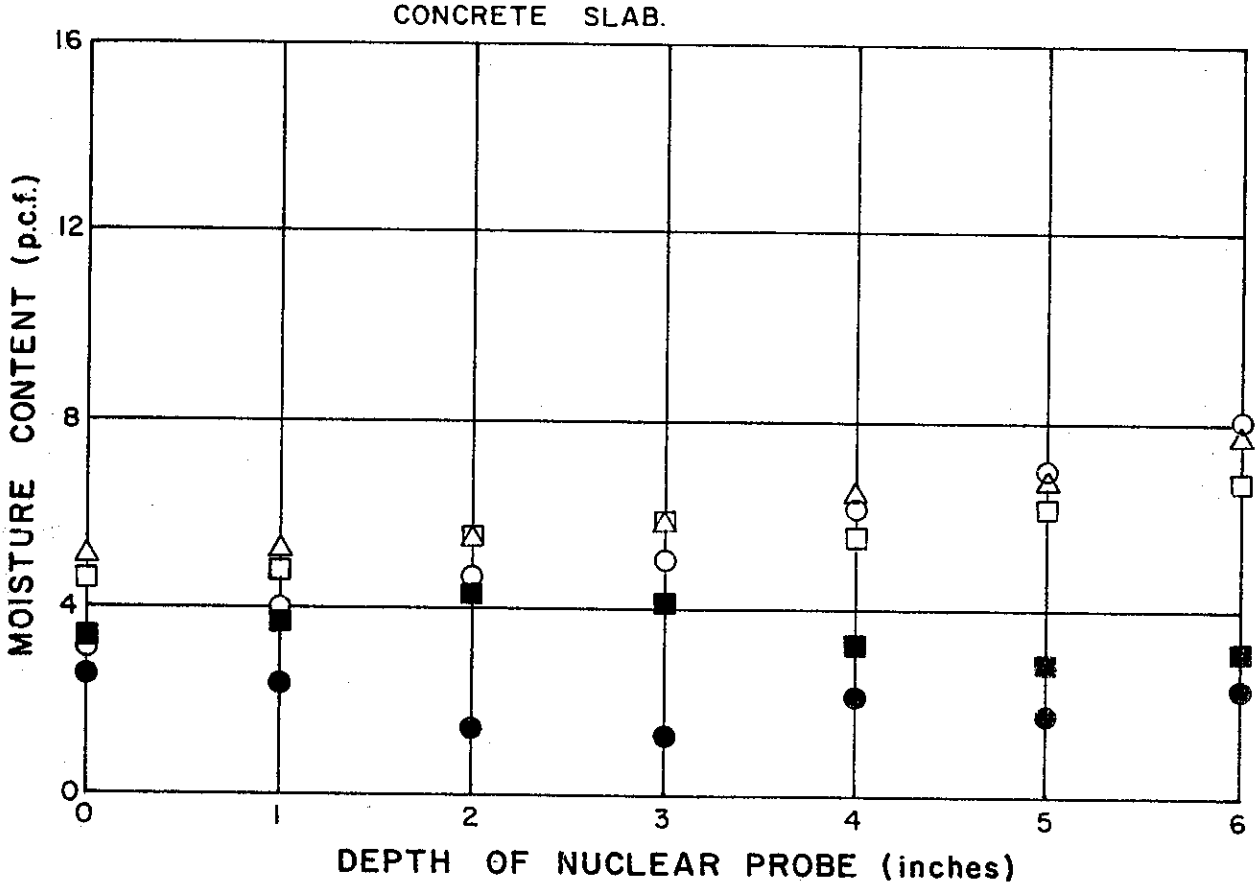

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Figure 6

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

HORIZONTAL CLEARANCE FROM NUCLEAR PROBE	1"	2"	3"
NUCLEAR MOSTURE CONTENT	○	△	□
OVEN DRY MOISTURE CONTENT	●	▲	■

RELATIVELY WET BACKFILL WITHOUT CONCRETE SLAB.

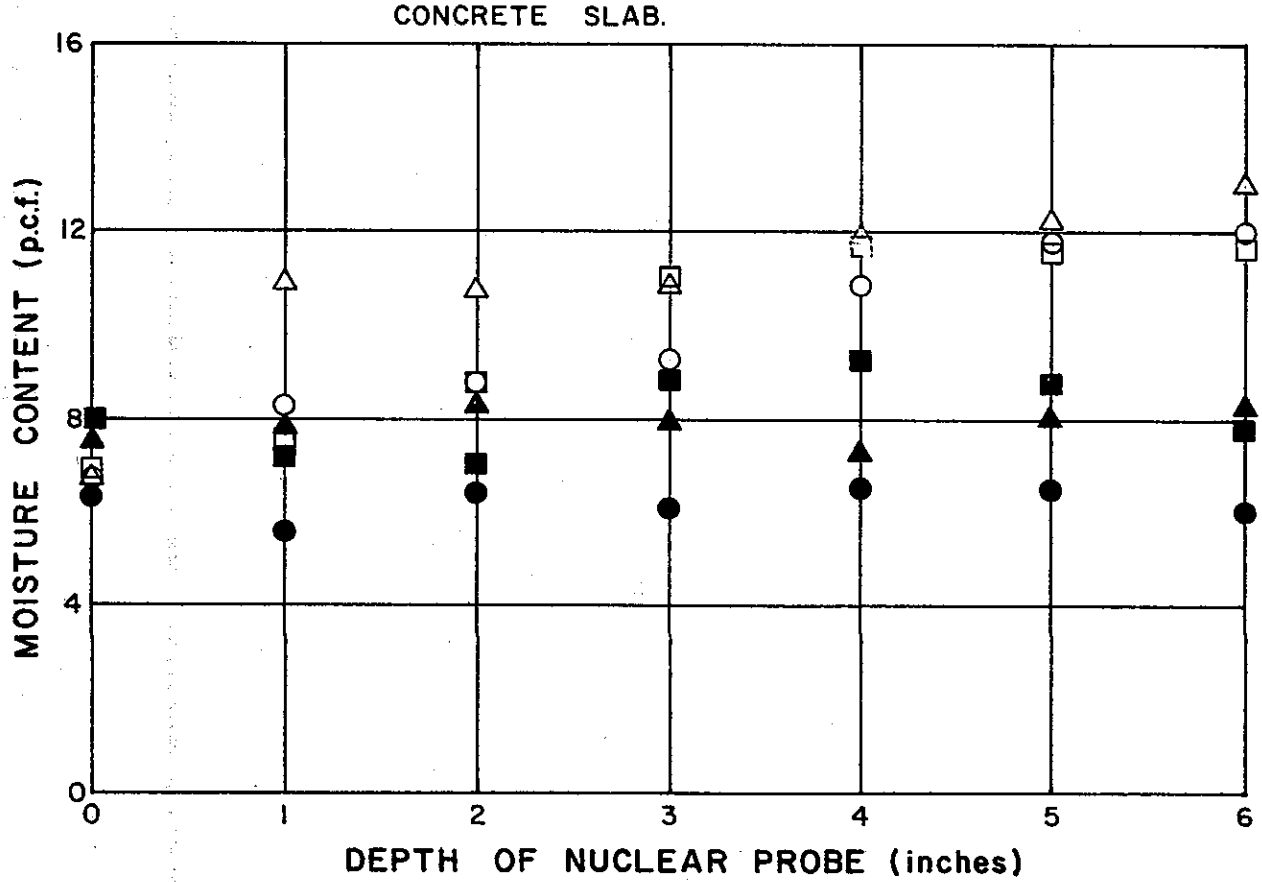

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Figure 7

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

AVERAGE MOISTURE CONTENT FOR 1", 2" & 3" CLEARANCE	BACKFILL RELATIVELY	
	DRY	WET
NUCLEAR – WITH CONCRETE SLAB	○	□
NUCLEAR – WITHOUT CONCRETE SLAB	△	◇
OVEN DRY – WITH & WITHOUT CONCRETE SLAB	✚	★

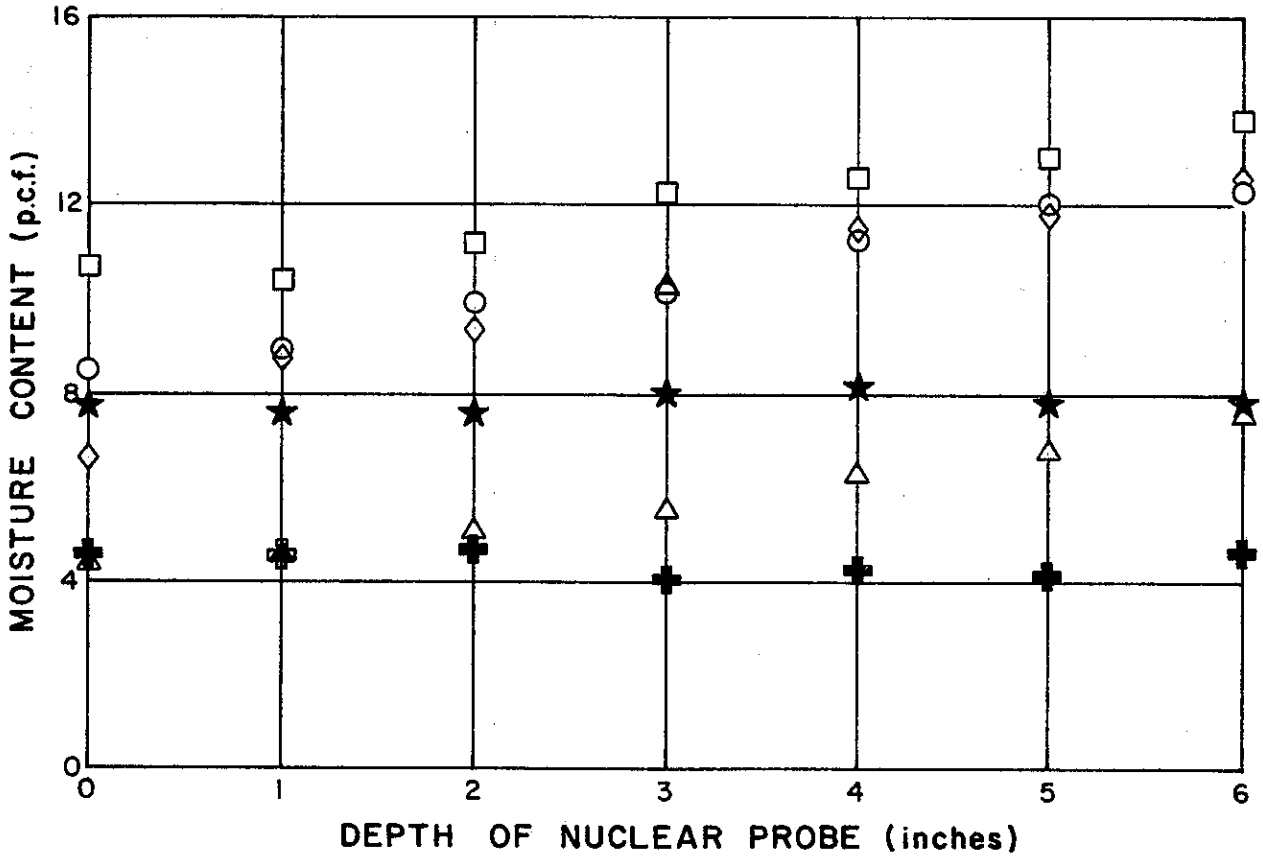

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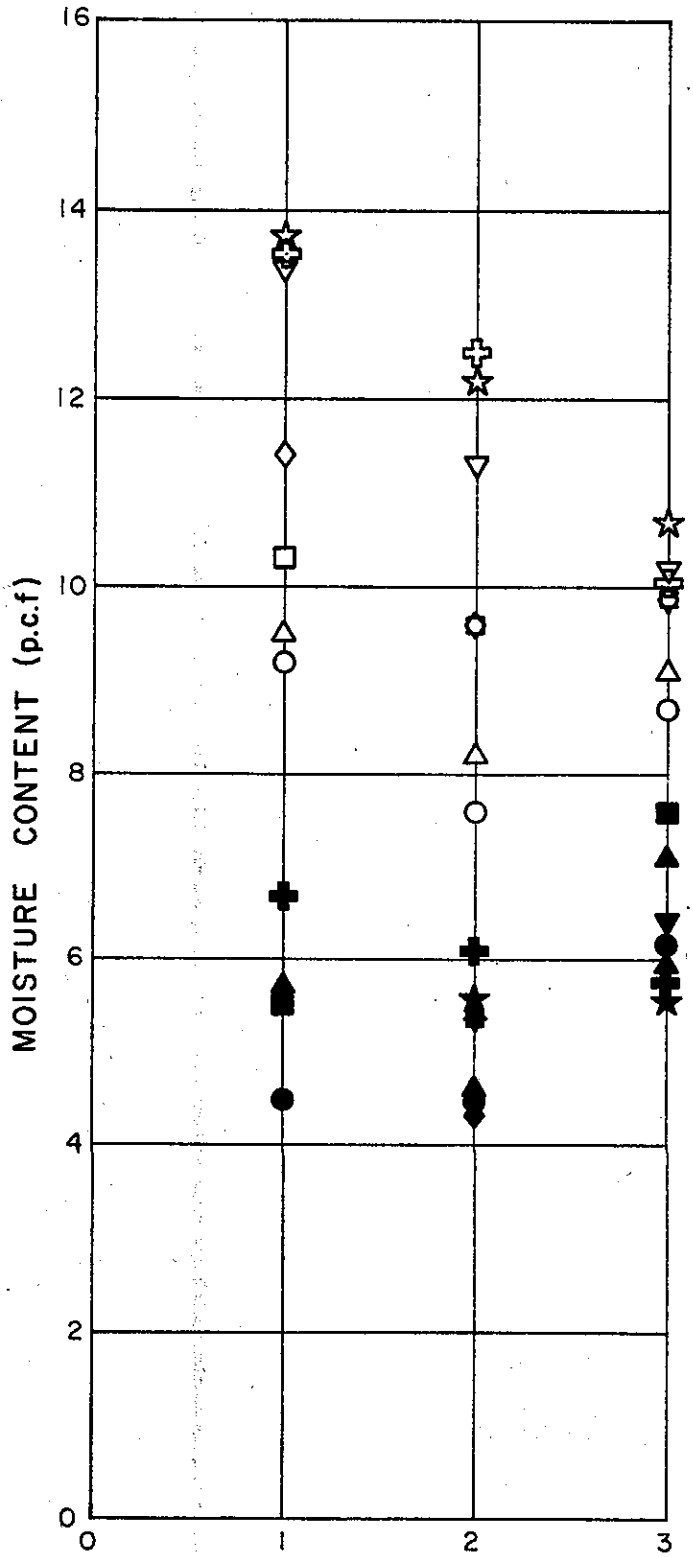
Figure 8

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



DEPTH OF PROBE	NUCLEAR MOISTURE CONTENT	OVEN DRY MOISTURE CONTENT
SURFACE	○	●
1"	△	▲
2"	□	■
3"	◇	◆
4"	▽	▼
5"	✚	✚
6"	☆	★

RELATIVELY DRY BACKFILL WITH CONCRETE SLAB.

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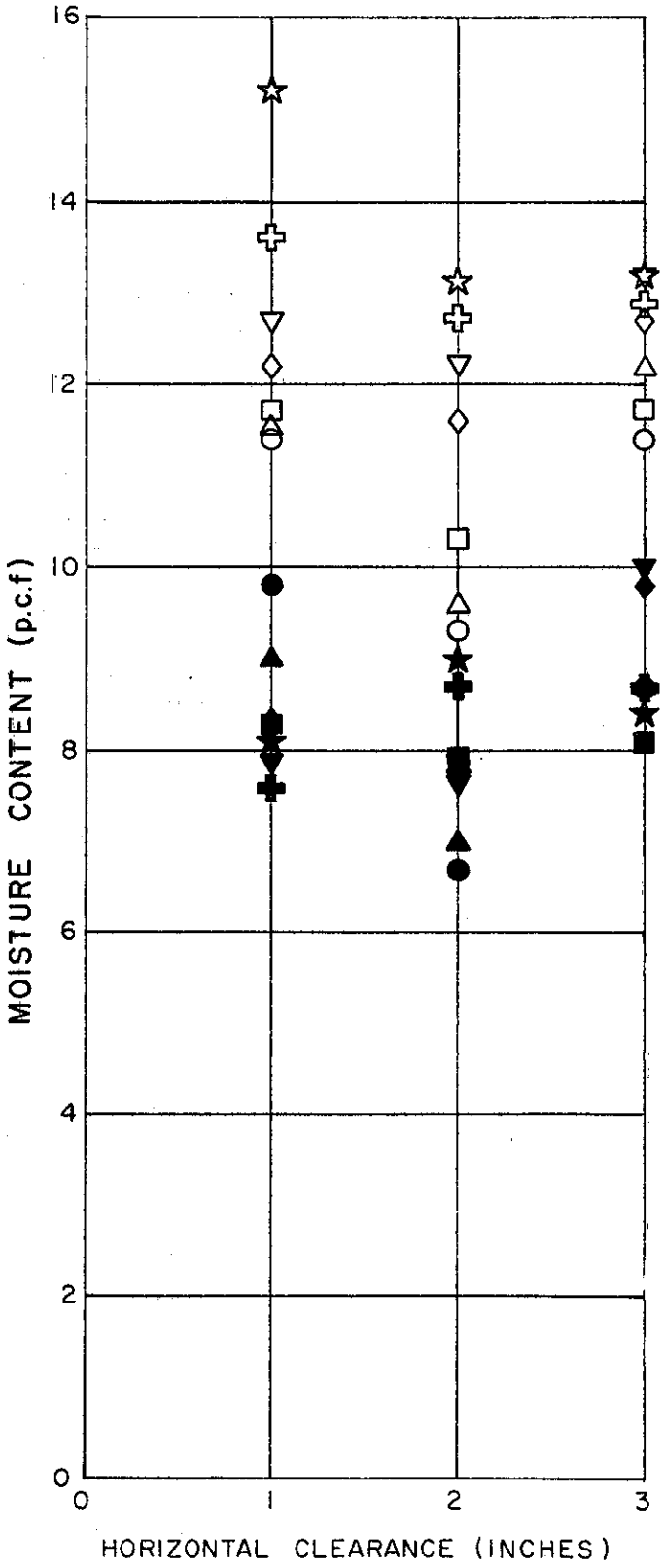
NO. M & R 642978

Figure 9

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



DEPTH OF PROBE	NUCLEAR MOISTURE CONTENT	OVEN DRY MOISTURE CONTENT
SURFACE	○	●
1"	△	▲
2"	□	■
3"	◇	◆
4"	▽	▼
5"	✚	✚
6"	☆	★

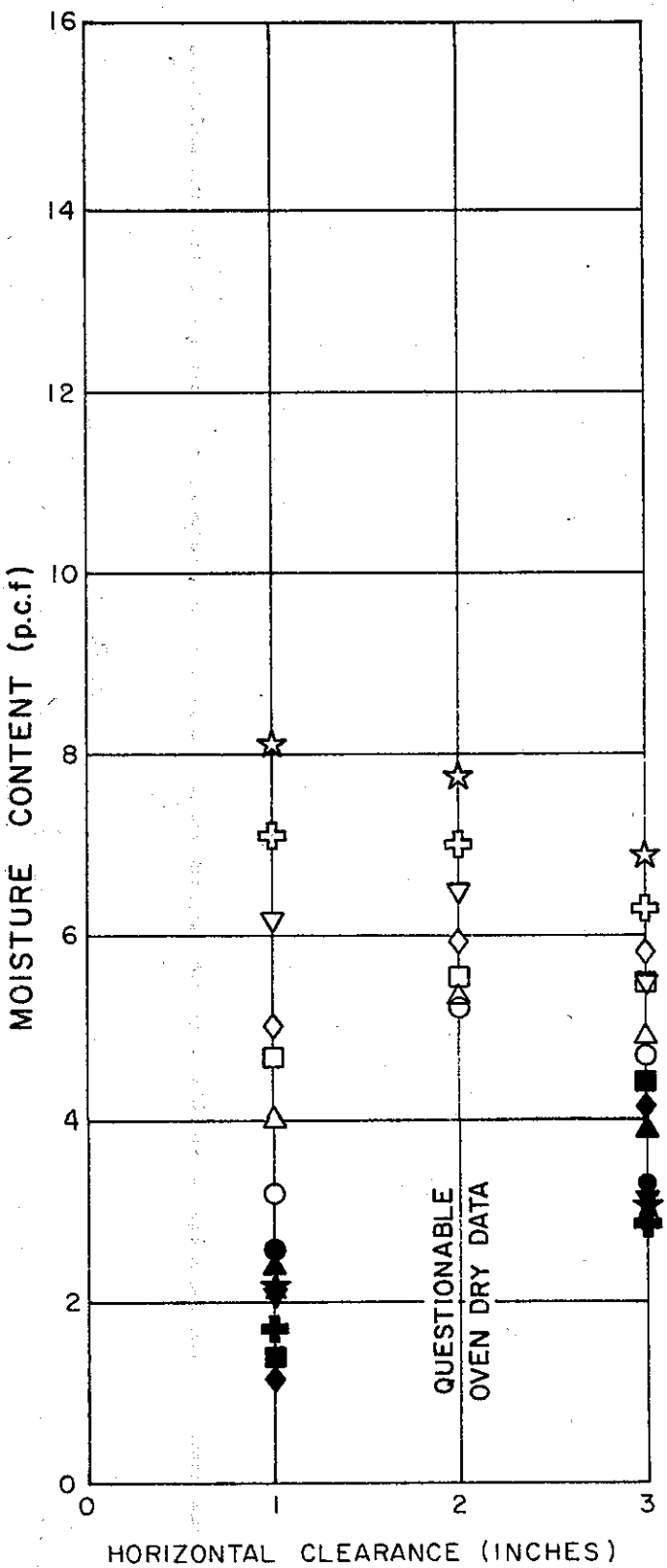
RELATIVELY WET BACKFILL WITH CONCRETE SLAB.

MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

Figure 10

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



DEPTH OF PROBE	NUCLEAR MOISTURE CONTENT	OVEN DRY MOISTURE CONTENT
SURFACE	○	●
1"	△	▲
2"	□	■
3"	◇	◆
4"	▽	▼
5"	✚	✚
6"	☆	★

RELATIVELY DRY BACKFILL WITHOUT CONCRETE SLAB.

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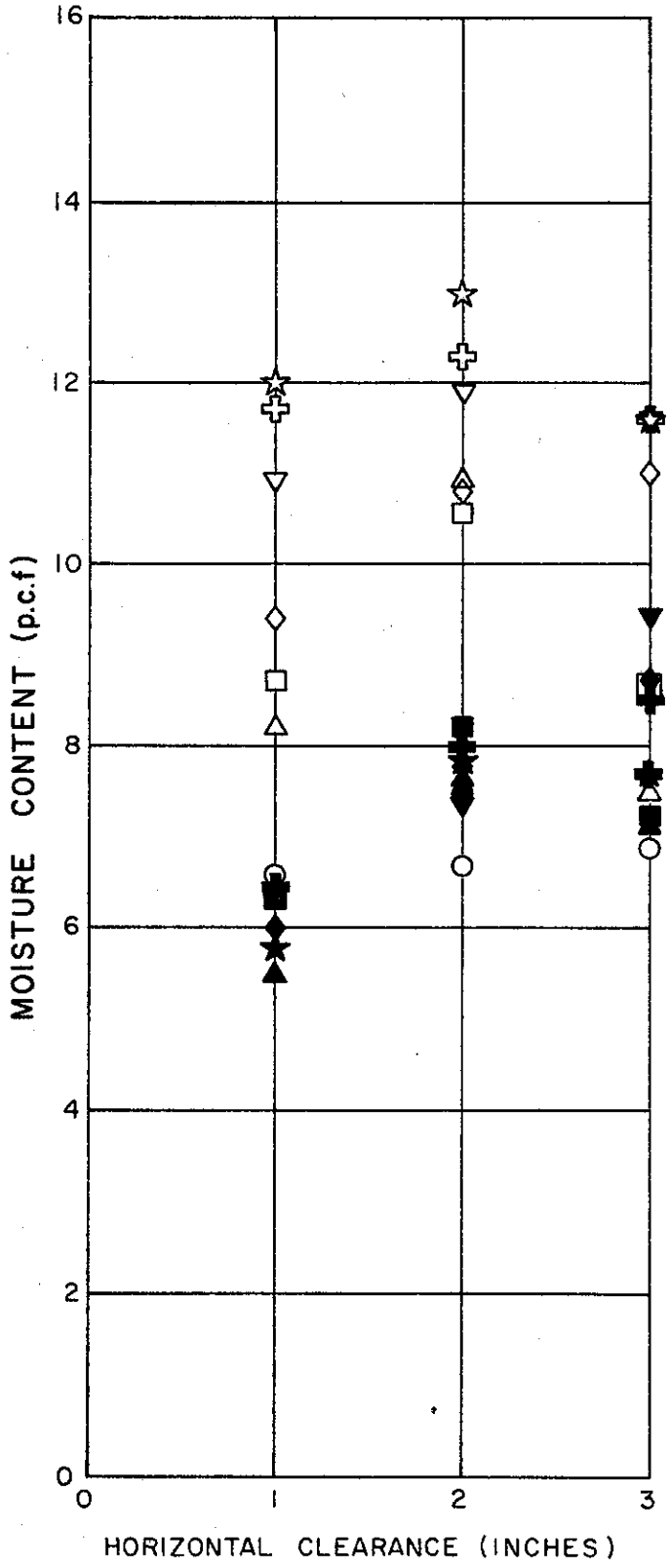
NO. M & R 642978

Figure 11

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



DEPTH OF PROBE	NUCLEAR MOISTURE CONTENT	OVEN DRY MOISTURE CONTENT
SURFACE	○	●
1"	△	▲
2"	□	■
3"	◇	◆
4"	▽	▼
5"	✚	✚
6"	☆	★

RELATIVELY WET BACKFILL WITHOUT CONCRETE SLAB.

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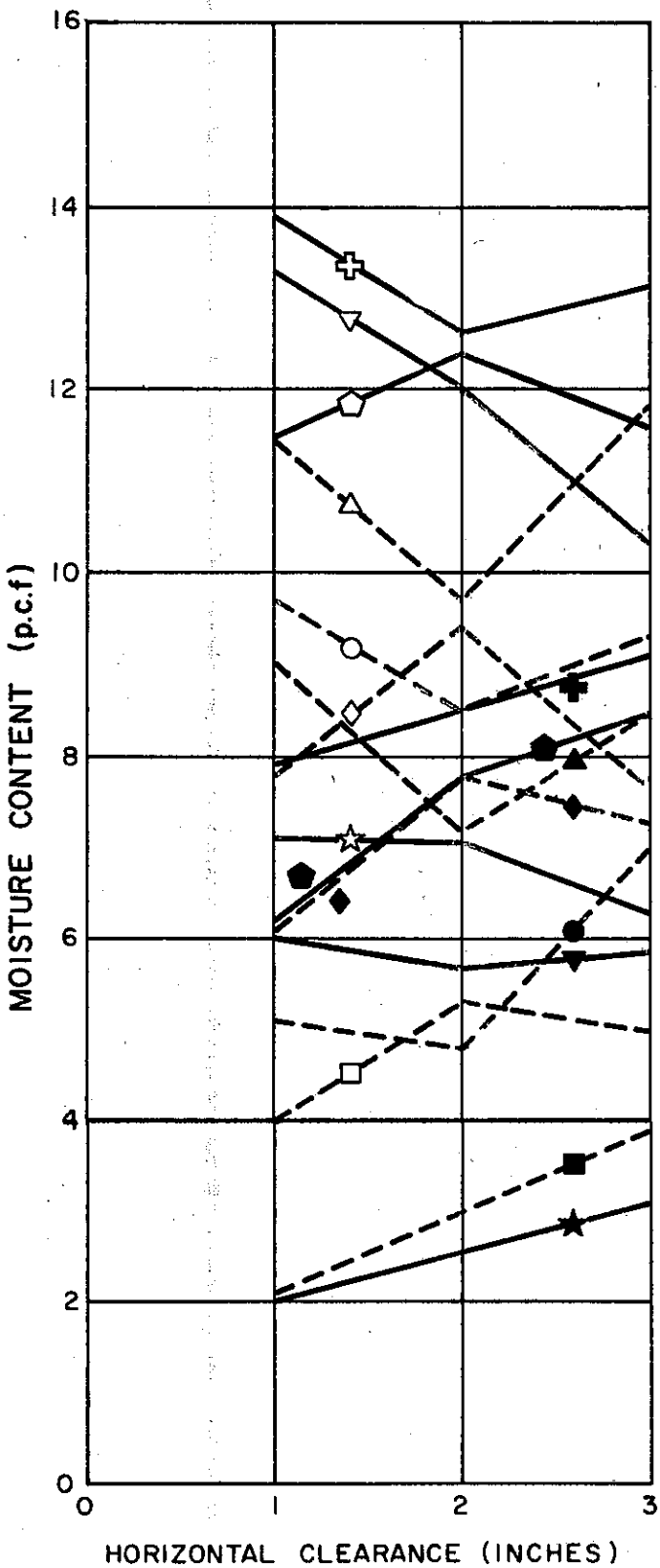
Figure 12

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



DEPTH OF PROBE	ADJUSTED MOISTURE CONTENT		BACKFILL MOISTURE CONDITION RELATIVELY		CONCRETE SLAB	
	NUCLEAR	OVEN DRY	DRY	WET	PRESENT	ABSENT
SURFACE 1" & 2"	○	●	✓		✓	
	△	▲		✓	✓	
	□	■	✓			✓
	◇	◆		✓		✓
4", 5", & 6"	▽	▼	✓		✓	
	✚	✚		✓	✓	
	☆	★	✓			✓
	⬠	⬟		✓		✓

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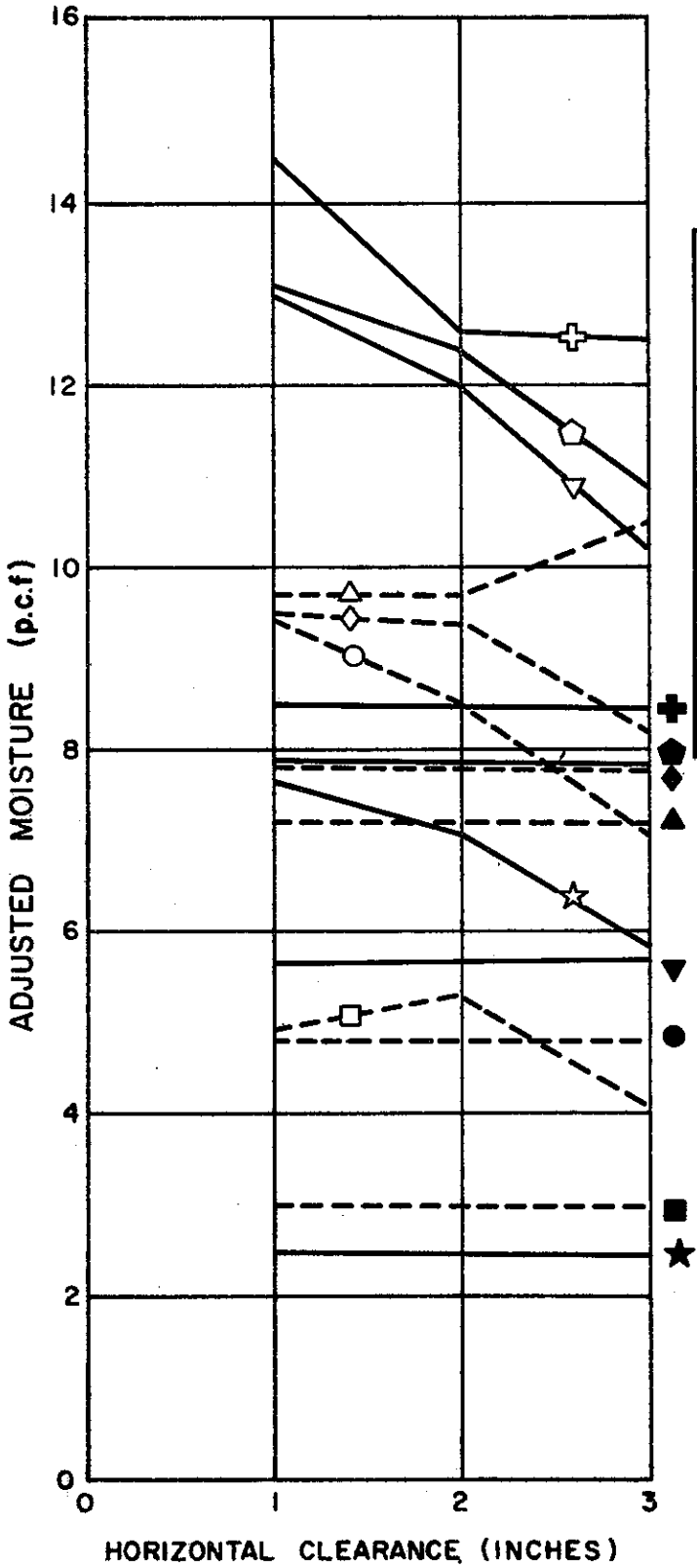
Figure 13

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



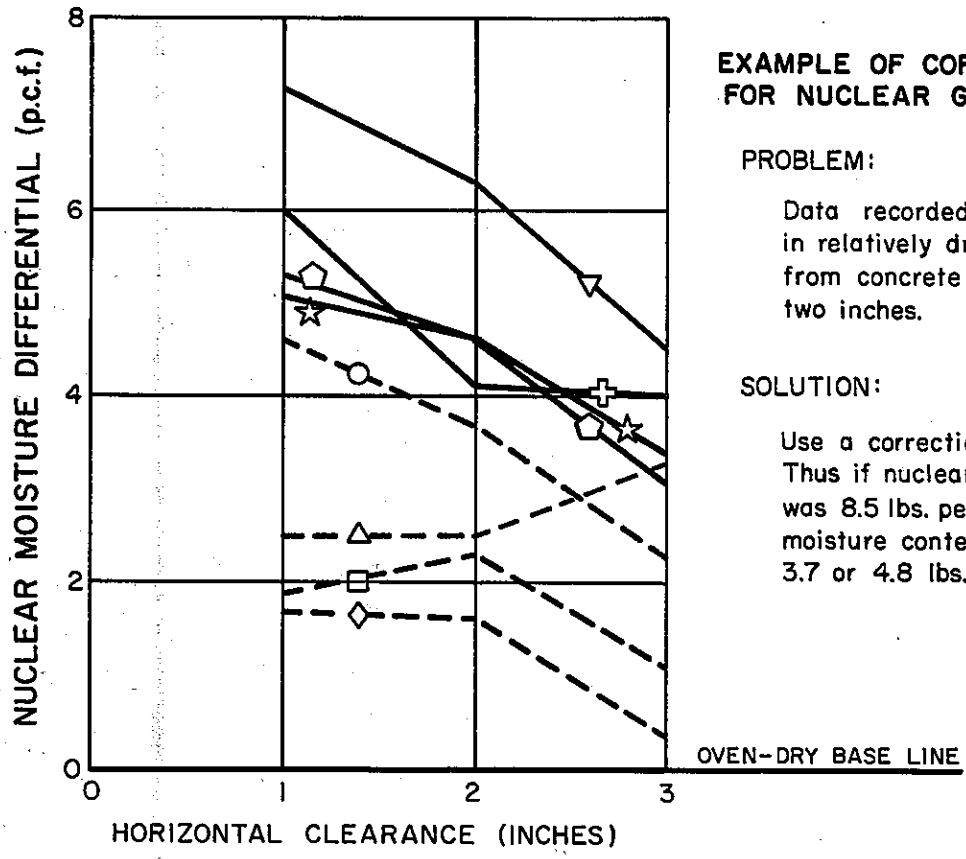
DEPTH OF PROBE	ADJUSTED MOISTURE CONTENT		BACKFILL MOISTURE CONDITION RELATIVELY		CONCRETE SLAB	
	NUCLEAR	OVEN DRY	DRY	WET	PRESENT	ABSENT
SURFACE 1" & 2"	○	●	✓		✓	
	△	▲		✓	✓	
	□	■	✓			✓
	◇	◆		✓		✓
4", 5", & 6"	▽	▼	✓		✓	
	✚	✚		✓	✓	
	☆	★	✓			✓
	⬠	⬟		✓		✓

MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

Figure 14

TROXLER GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



EXAMPLE OF CORRECTION FACTOR FOR NUCLEAR GAGE.

PROBLEM:

Data recorded when Troxler probe in relatively dry soil two inches from concrete slab at a depth of two inches.

SOLUTION:

Use a correction of 3.7 lbs. per. cu. ft., Thus if nuclear moisture determination was 8.5 lbs. per. cu. ft., the corrected moisture content would be 8.5 minus 3.7 or 4.8 lbs. per. cu. ft..

DEPTH OF PROBE	NUCLEAR MOISTURE DIFFER-ENTIAL	BACKFILL MOISTURE CONDITION RELATIVELY		CONCRETE SLAB	
		DRY	WET	PRESENT	ABSENT
SURFACE 1" & 2"	○	✓		✓	
	△		✓	✓	
	□	✓			✓
	◇		✓		✓
4", 5", & 6"	▽	✓		✓	
	✚		✓	✓	
	☆	✓			✓
	⬠		✓		✓

MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

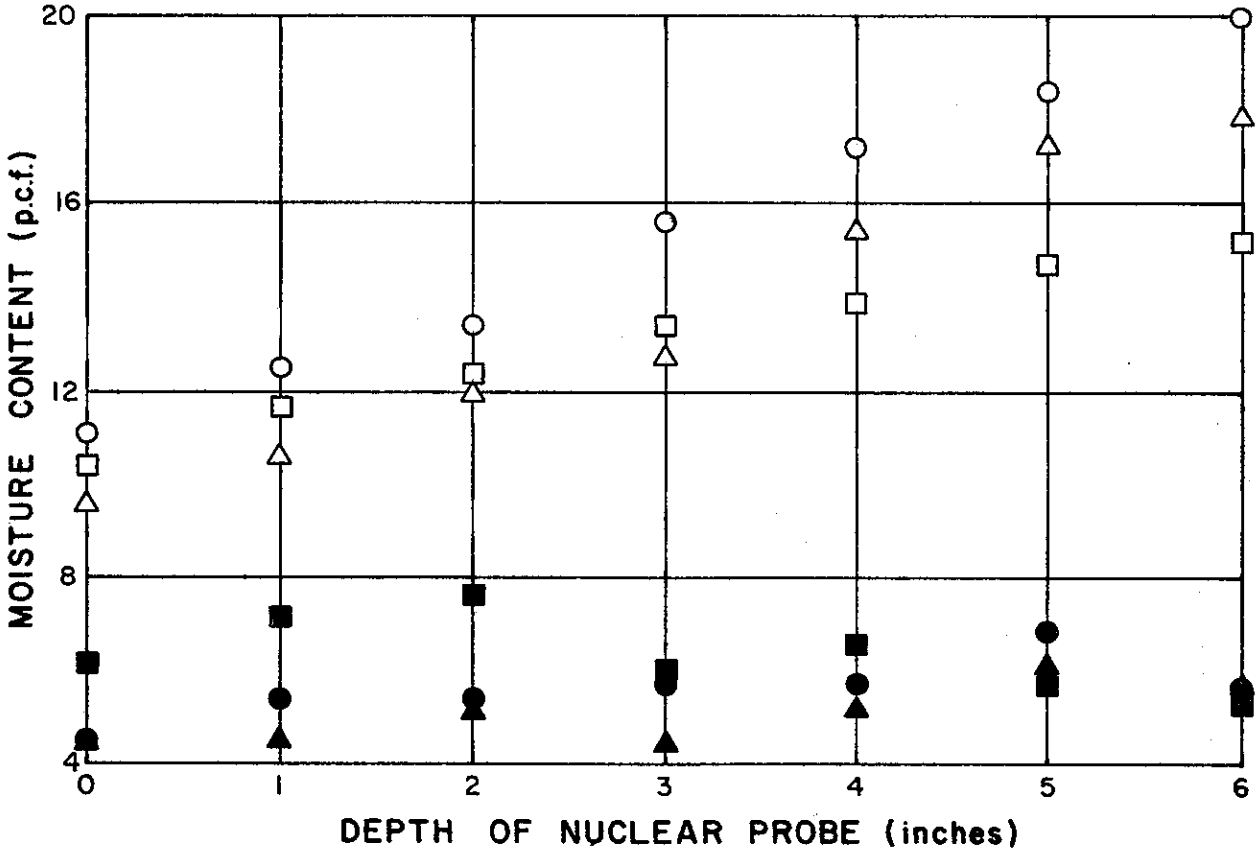
Figure 15

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

HORIZONTAL CLEARANCE FROM NUCLEAR PROBE	1"	2"	3"
NUCLEAR MOSTURE CONTENT	○	△	□
OVEN DRY MOISTURE CONTENT	●	▲	■

RELATIVELY DRY BACKFILL WITH CONCRETE SLAB.



MATERIALS AND RESEARCH DEPARTMENT
NO. M&R 642978

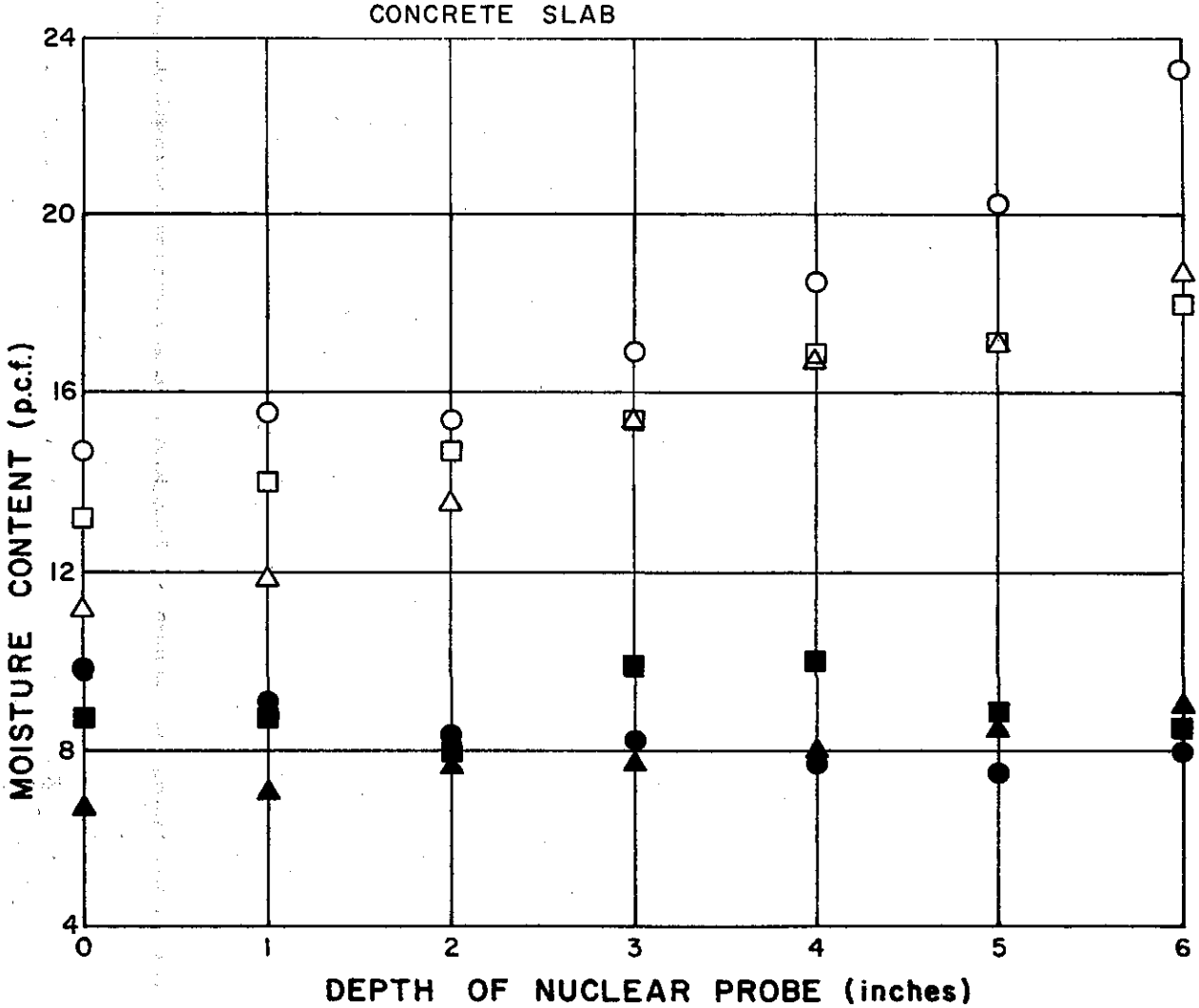
Figure 16

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

HORIZONTAL CLEARANCE FROM NUCLEAR PROBE	1"	2"	3"
NUCLEAR MOISTURE CONTENT	○	△	□
OVEN DRY MOISTURE CONTENT	●	▲	■

RELATIVELY WET BACKFILL WITH
CONCRETE SLAB



MATERIALS AND RESEARCH DEPARTMENT
NO. M&R 642978

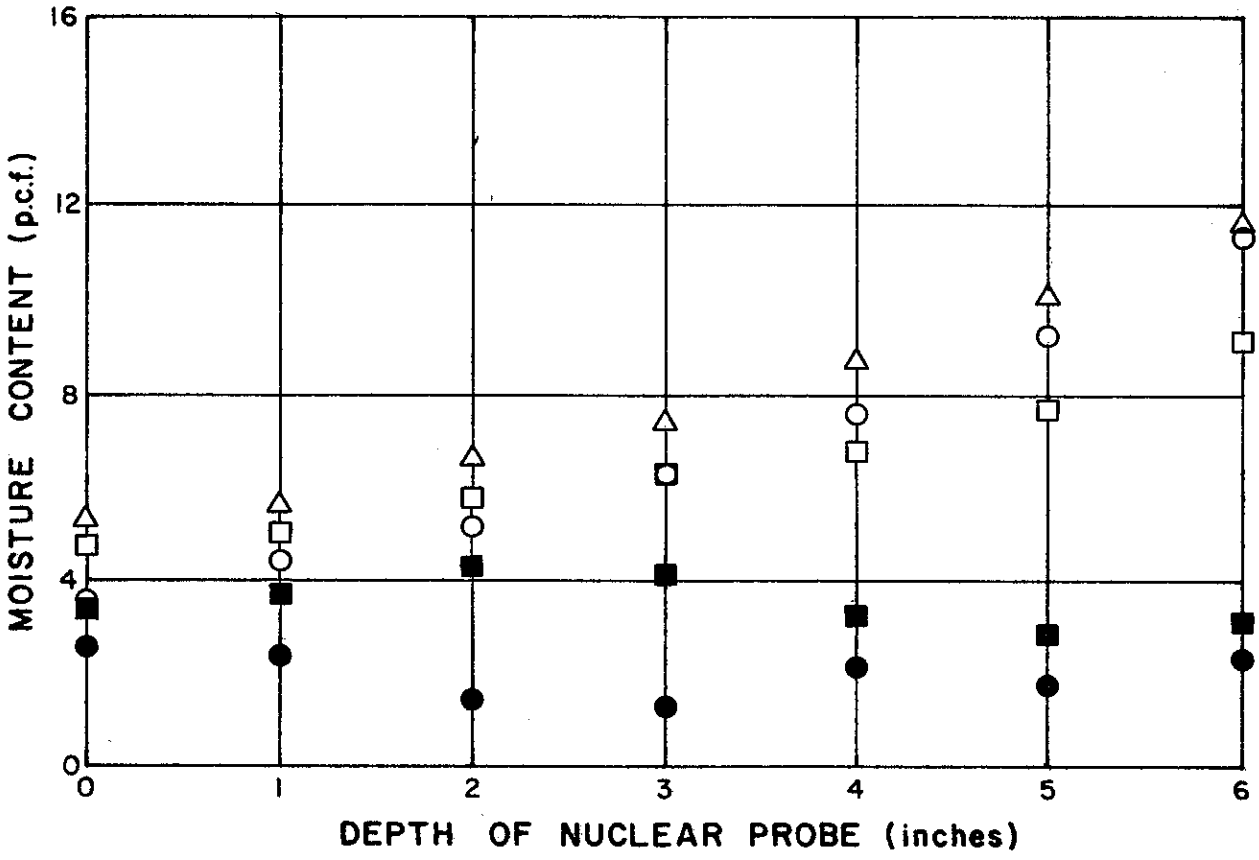
Figure 17

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

HORIZONTAL CLEARANCE FROM NUCLEAR PROBE	1"	2"	3"
NUCLEAR MOSTURE CONTENT	○	△	□
OVEN DRY MOISTURE CONTENT	●		■

RELATIVELY DRY BACKFILL WITHOUT
CONCRETE SLAB.



MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

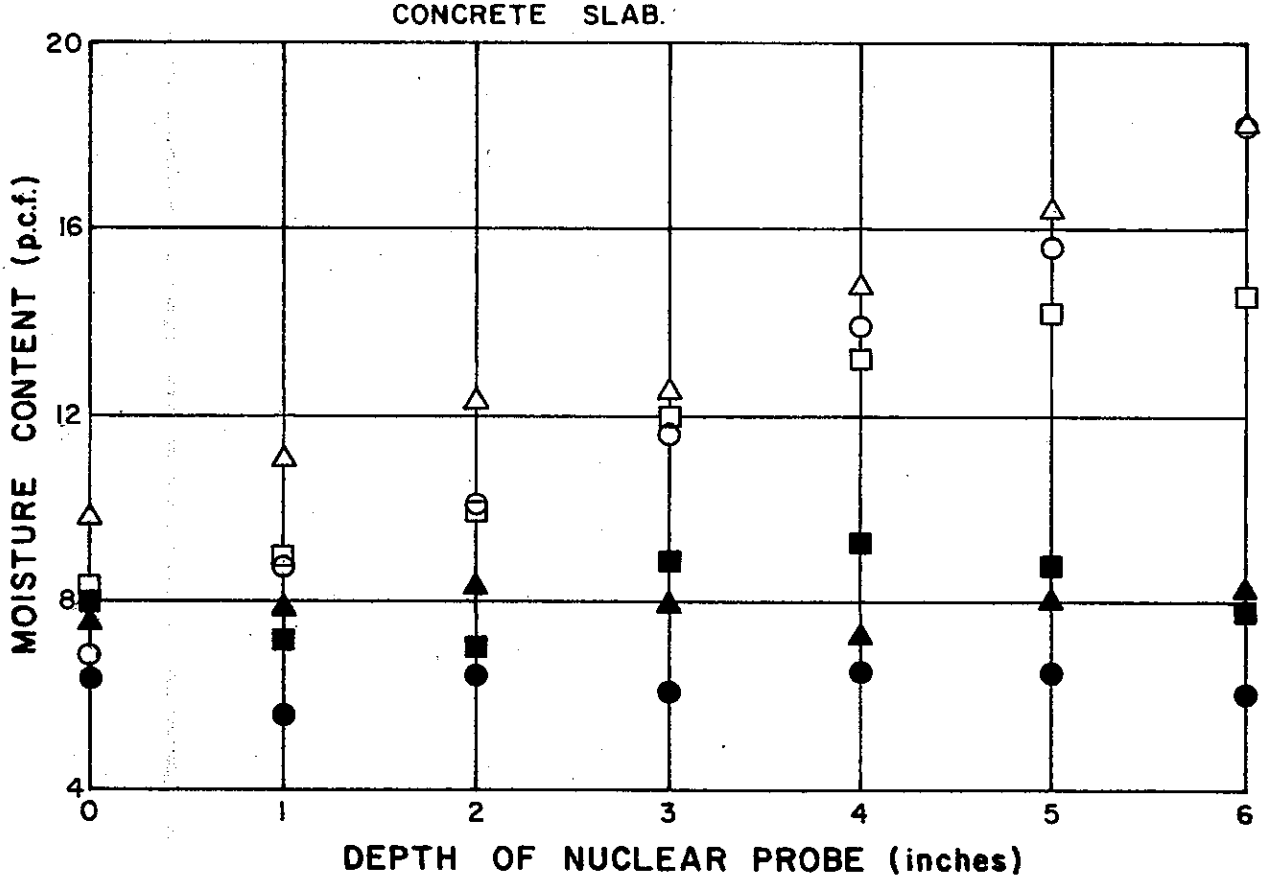
Figure 18

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

HORIZONTAL CLEARANCE FROM NUCLEAR PROBE	1"	2"	3"
NUCLEAR MOSTURE CONTENT	○	△	□
OVEN DRY MOISTURE CONTENT	●	▲	■

RELATIVELY WET BACKFILL WITHOUT CONCRETE SLAB.



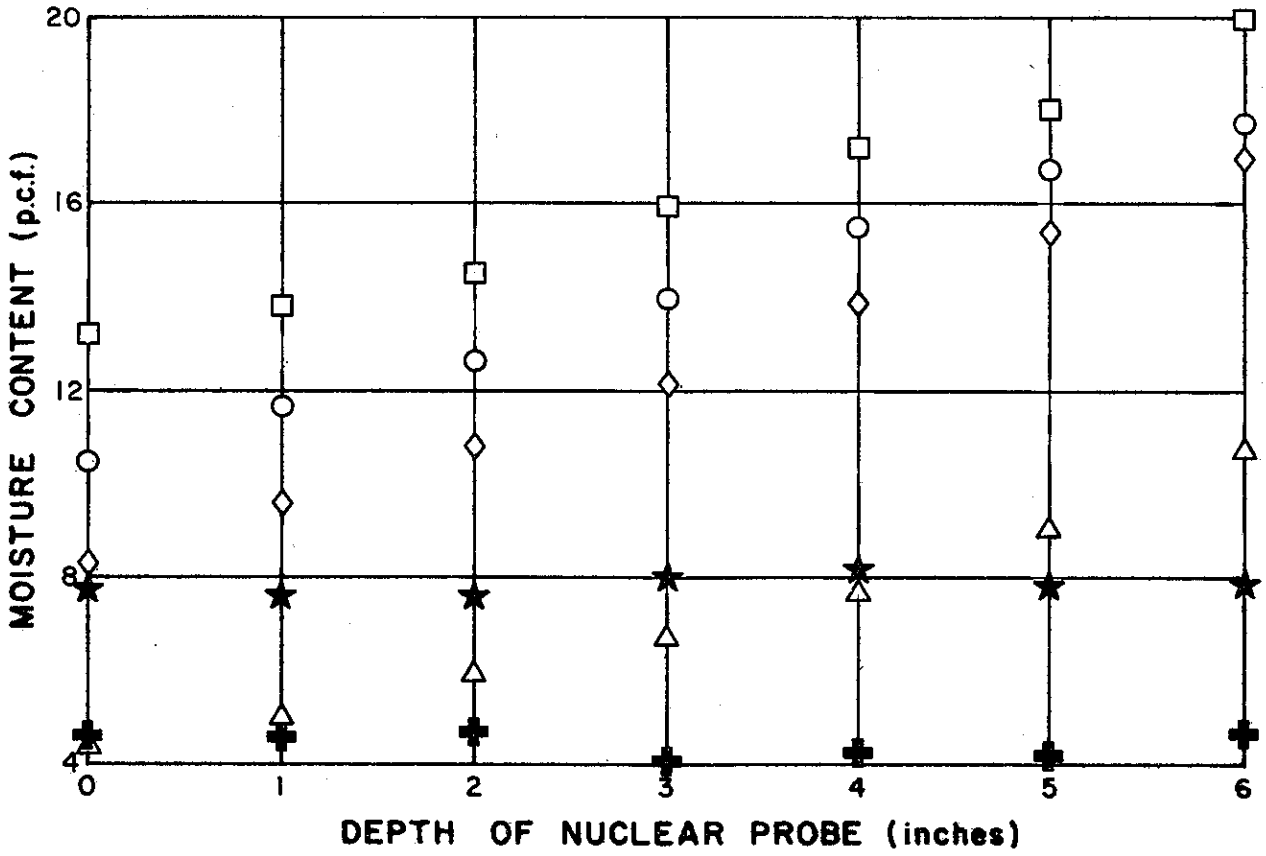
MATERIALS AND RESEARCH DEPARTMENT
NO. M&R 642978

Figure 19

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

AVERAGE MOISTURE CONTENT FOR 1", 2" & 3" CLEARANCE	BACKFILL RELATIVELY DRY	BACKFILL RELATIVELY WET
NUCLEAR – WITH CONCRETE SLAB	○	□
NUCLEAR – WITHOUT CONCRETE SLAB	△	◇
OVEN DRY – WITH & WITHOUT CONCRETE SLAB	✚	★

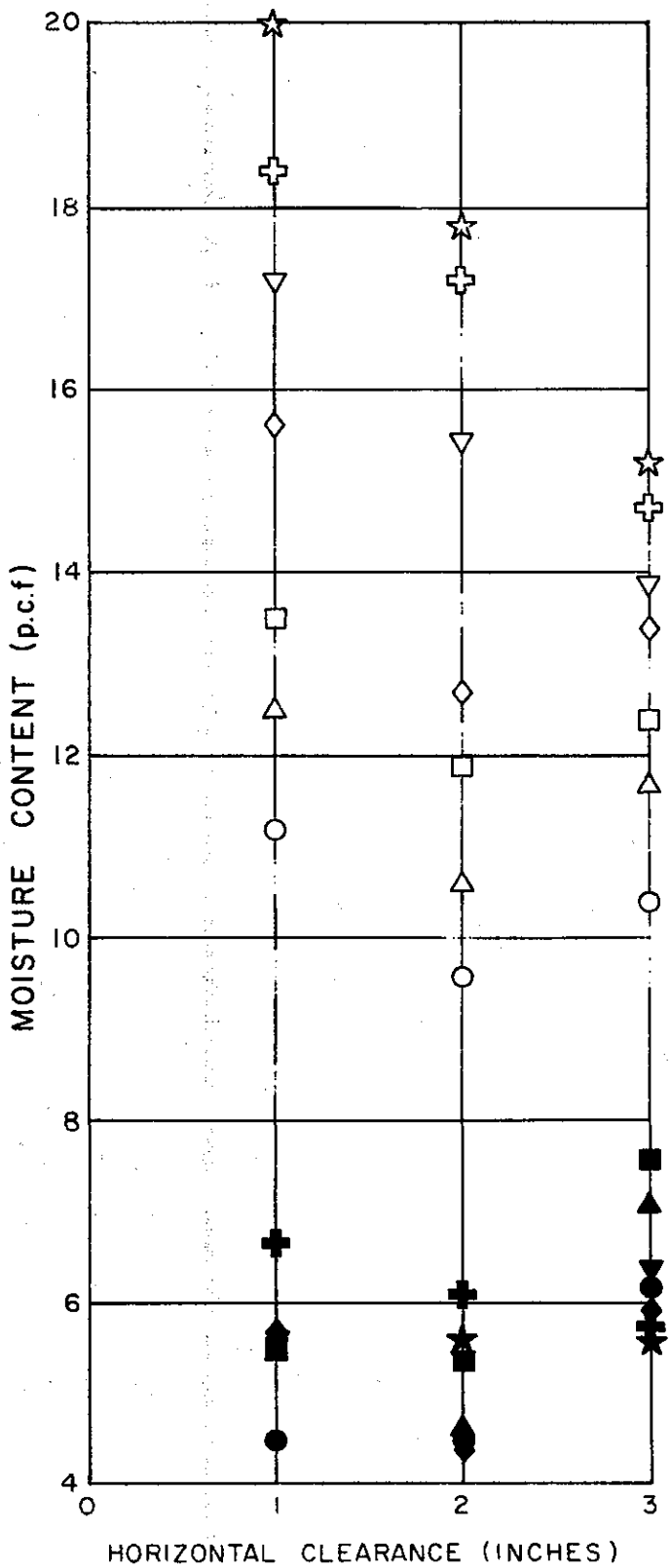


MATERIALS AND RESEARCH DEPARTMENT
NO. M&R 642978

Figure 20

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



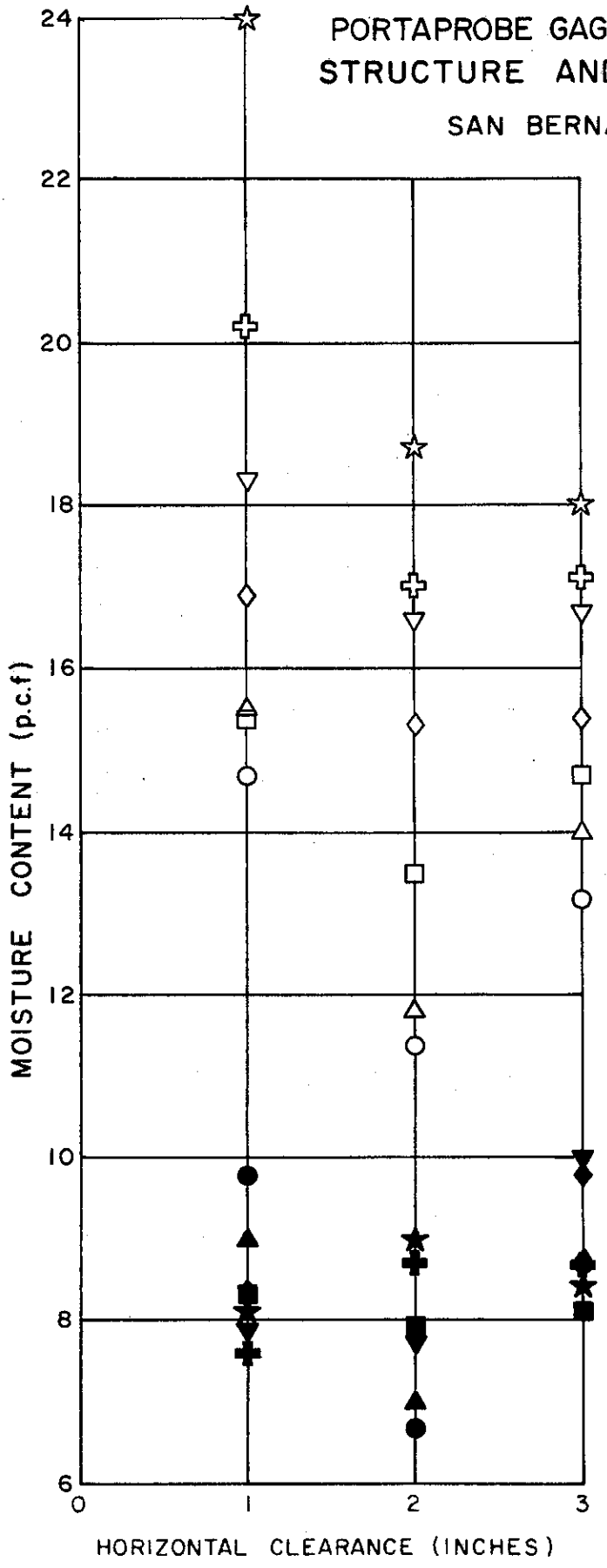
DEPTH OF PROBE	NUCLEAR MOISTURE CONTENT	OVEN DRY MOISTURE CONTENT
SURFACE	○	●
1"	△	▲
2"	□	■
3"	◇	◆
4"	▽	▼
5"	✚	✚
6"	☆	★

RELATIVELY DRY BACKFILL WITH CONCRETE SLAB.

MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

Figure 21

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL
SAN BERNARDINO COUNTY



DEPTH OF PROBE	NUCLEAR MOISTURE CONTENT	OVEN DRY MOISTURE CONTENT
SURFACE	○	●
1"	△	▲
2"	□	■
3"	◇	◆
4"	▽	▼
5"	✚	✚
6"	☆	★

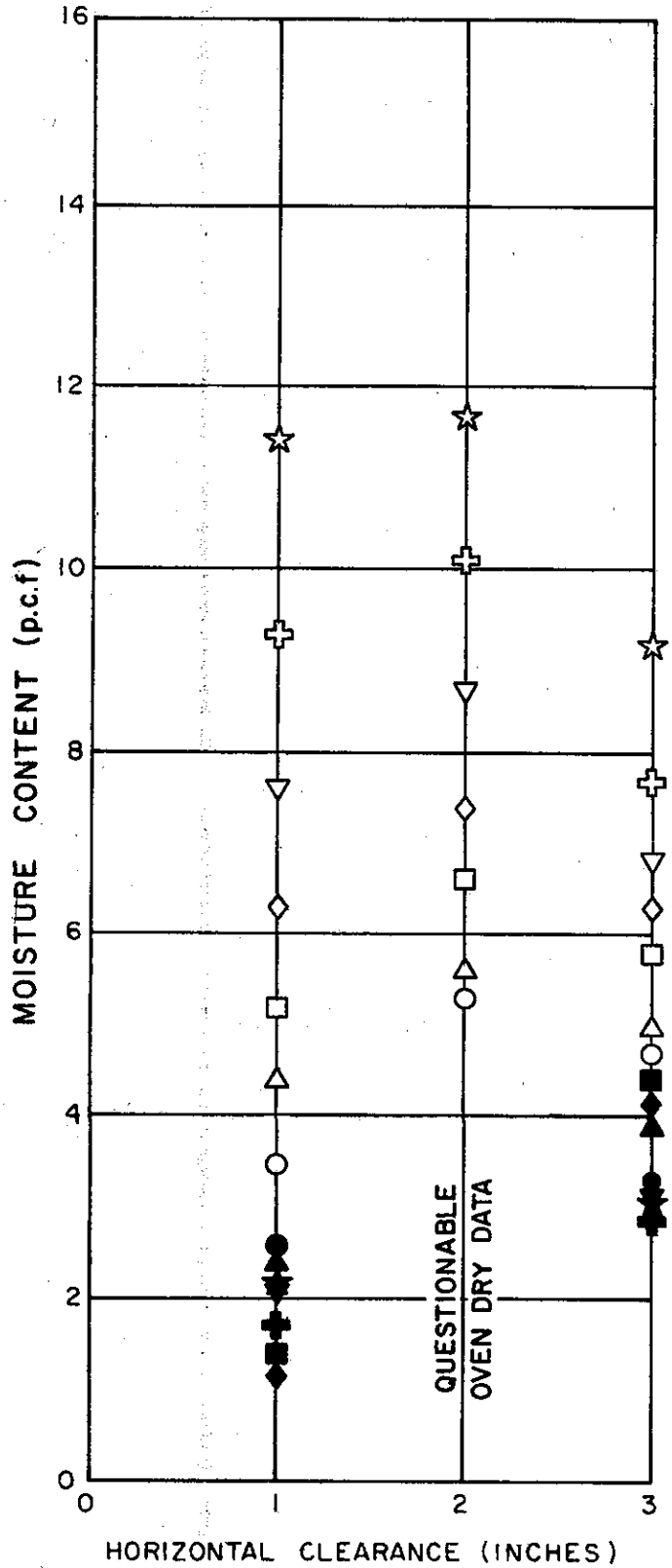
RELATIVELY WET BACKFILL WITH CONCRETE SLAB.

MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

Figure 22

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



DEPTH OF PROBE	NUCLEAR MOISTURE CONTENT	OVEN DRY MOISTURE CONTENT
SURFACE	○	●
1"	△	▲
2"	□	■
3"	◇	◆
4"	▽	▼
5"	✚	✚
6"	☆	★

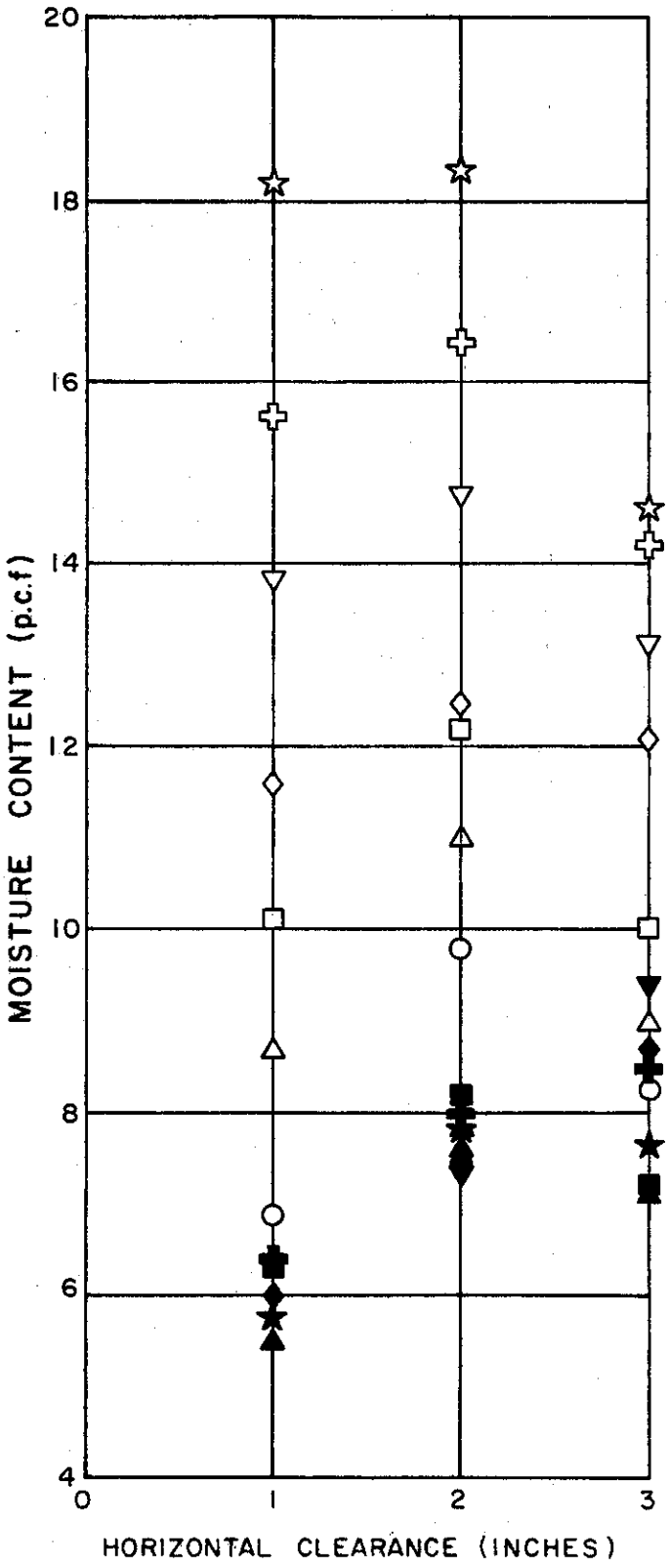
RELATIVELY DRY BACKFILL WITHOUT CONCRETE SLAB.

MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

Figure 23

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY



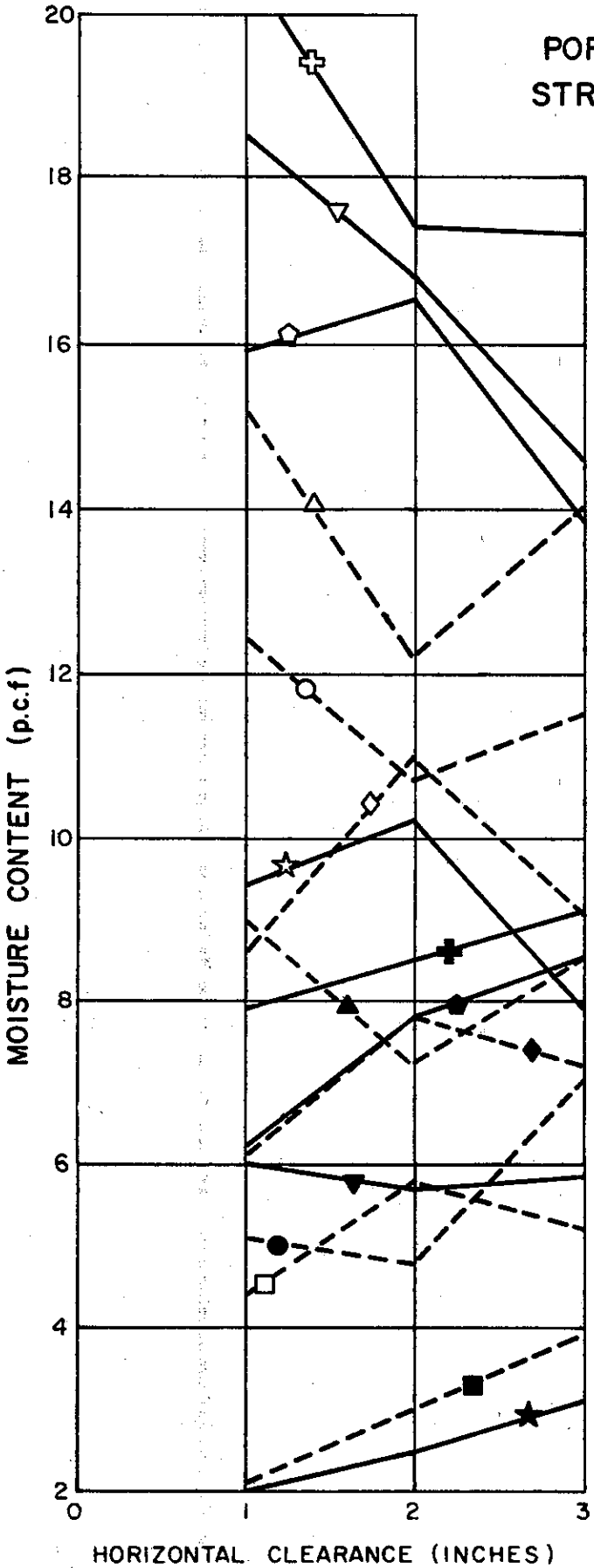
DEPTH OF PROBE	NUCLEAR MOISTURE CONTENT	OVEN DRY MOISTURE CONTENT
SURFACE	○	●
1"	△	▲
2"	□	■
3"	◇	◆
4"	▽	▼
5"	✚	✚
6"	☆	★

RELATIVELY WET BACKFILL WITHOUT CONCRETE SLAB

MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

Figure 24

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL
SAN BERNARDINO COUNTY

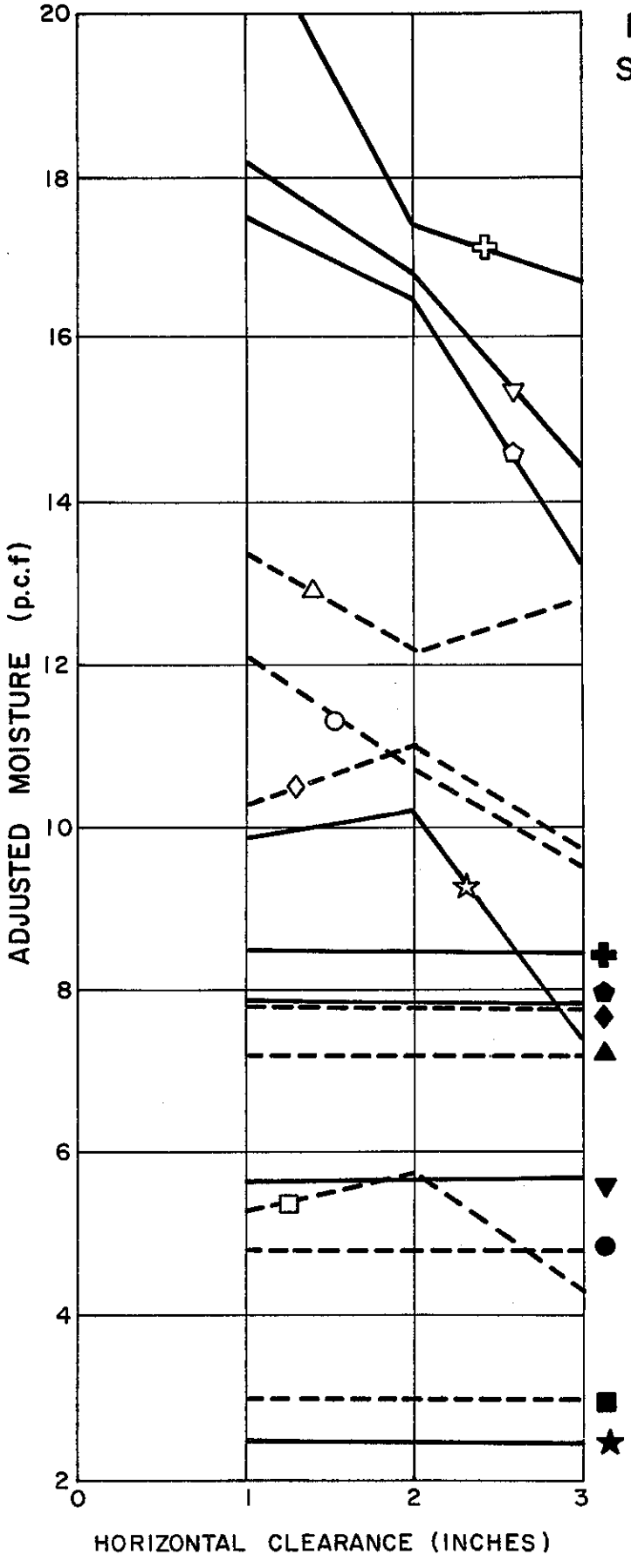


DEPTH OF PROBE	ADJUSTED MOISTURE CONTENT		BACKFILL MOISTURE CONDITION RELATIVELY		CONCRETE SLAB	
	NUCLEAR	OVEN DRY	DRY	WET	PRESENT	ABSENT
SURFACE 1" & 2"	○	●	✓		✓	
	△	▲		✓	✓	
	□	■	✓			✓
	◇	◆		✓		✓
4", 5", & 6"	▽	▼	✓		✓	
	✚	✚		✓	✓	
	☆	★	✓			✓
	⬠	⬟		✓		✓

MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

Figure 25

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL
SAN BERNARDINO COUNTY



DEPTH OF PROBE	ADJUSTED MOISTURE CONTENT		BACKFILL MOISTURE CONDITION RELATIVELY		CONCRETE SLAB	
	NUCLEAR	OVEN DRY	DRY	WET	PRESENT	ABSENT
SURFACE 1" & 2" (- - -)	○	●	✓		✓	
	△	▲		✓	✓	
	□	■	✓			✓
	◇	◆		✓		✓
4", 5", & 6" (———)	▽	▼	✓		✓	
	✚	✚		✓	✓	
	☆	★	✓			✓
	⬠	⬟		✓		✓

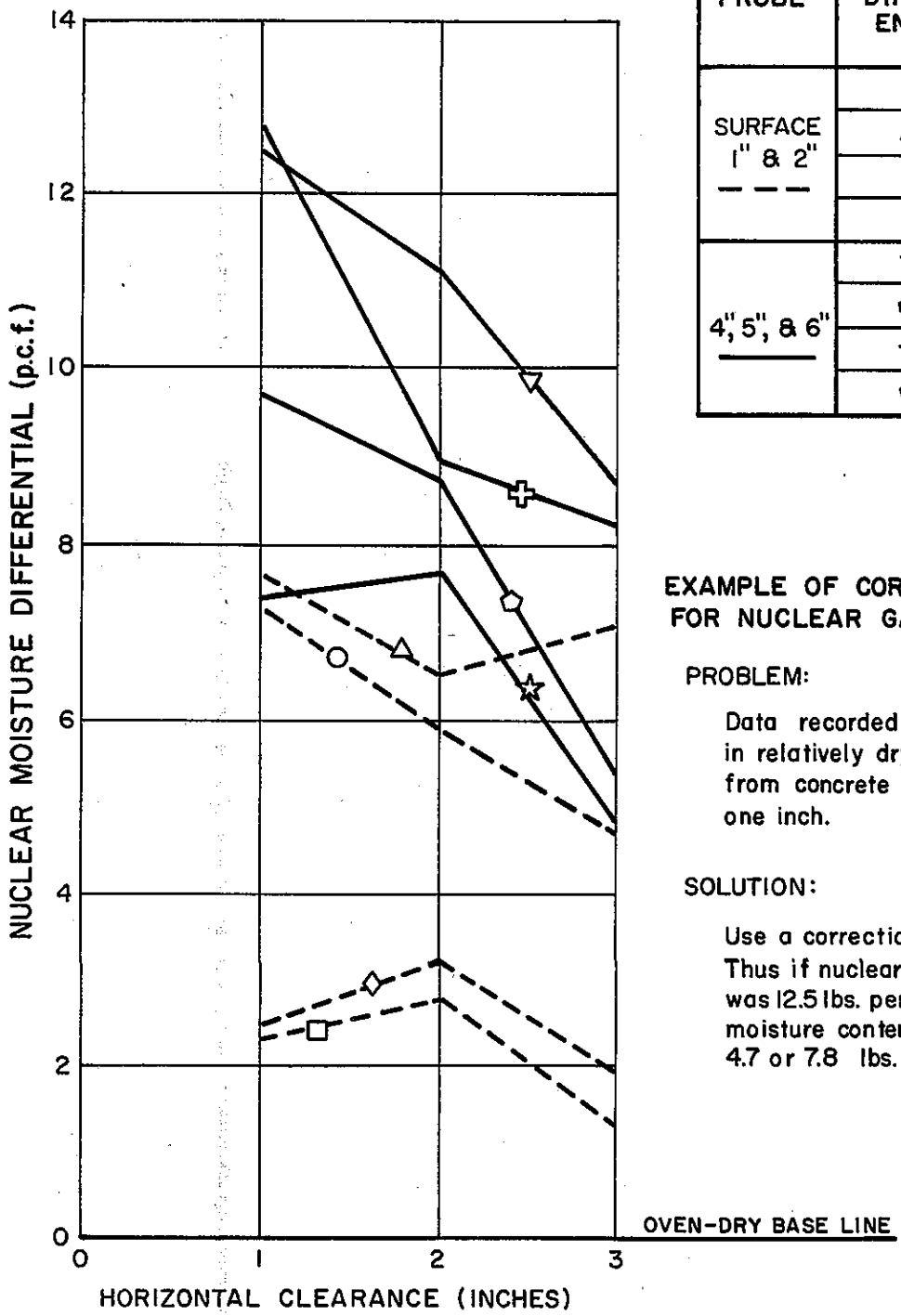
MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978

Figure 26

PORTAPROBE GAGE MOISTURE STUDY
STRUCTURE AND BRIDGE BACKFILL

SAN BERNARDINO COUNTY

DEPTH OF PROBE	NUCLEAR MOISTURE DIFFERENTIAL	BACKFILL MOISTURE CONDITION RELATIVELY		CONCRETE SLAB	
		DRY	WET	PRESENT	ABSENT
SURFACE 1" & 2" — — —	○	✓		✓	
	△		✓	✓	
	□	✓			✓
	◇		✓		✓
4", 5", & 6" ———	▽	✓		✓	
	✚		✓	✓	
	☆	✓			✓
	⬠		✓		✓



EXAMPLE OF CORRECTION FACTOR FOR NUCLEAR GAGE.

PROBLEM:

Data recorded when Portaprobe in relatively dry soil three inches from concrete slab at a depth of one inch.

SOLUTION:

Use a correction of 4.7 lbs. per. cu. ft.. Thus if nuclear moisture determination was 12.5 lbs. per. cu. ft., the corrected moisture content would be 12.5 minus 4.7 or 7.8 lbs. per. cu. ft..

MATERIALS AND RESEARCH DEPARTMENT
NO. M & R 642978