GR-84-15

ADJUSTMENT OF AUTOMATIC COMPACTION DEVICES TO ACHIEVE UNIFORM RAMMER COVERAGE

December 1984

Engineering and Research Center

U.S. Department of the Interior
Bureau of Reclamation
Division of Research and
Laboratory Services
Geotechnical Branch

7-2090 (4-81)
Bureau of Reclamation

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. GR-84-15	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE Adjustment of Automatic Compaction Devices to Achieve Uniform Rammer Coverage		5. REPORT DATE December 1984 6. PERFORMING ORGANIZATION CODE D-1541
7. AUTHOR(S) Vaughan D. Goldsmith DeWayne A. Campbell		8. PERFORMING ORGANIZATION REPORT NO. GR-84-15
9. PERFORMING ORGANIZATION NAME AND ADDRESS Bureau of Reclamation Engineering and Research Center Denver, CO 80225		10. WORK UNIT NO. 11. CONTRACT OR GRANT NO. 13. TYPE OF REPORT AND PERIOD COVERED
12. SPONSORING AGENCY NAME AND ADDRESS Bureau of Reclamation Engineering and Research Center Denver, CO 80225		14. SPONSORING AGENCY CODE DIBR

15. SUPPLEMENTARY NOTES

Microfiche and/or hard copy available at the Engineering and Research Center, Denver, Colorado.

Editor:REC(c)

16. ABSTRACT

A study was performed to determine the proper rotational adjustment of automatic soil compaction devices. Compaction tests were performed to investigate the effects of varying the rotational adjustment. Adjustments that produced from 6.25 to 10.5 blows per revolution yielded acceptable results, with 8.33 blows per revolution the recommended value. Adjustment of the equipment to achieve 8.33 blows per revolution involves a relatively simple seven-step procedure.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS-- soil testing/ Proctor compaction/ *automatic compaction device/ *compaction equipment/ *compaction tests/ compaction

b. IDENTIFIERS--

c. COSATI Field/Group 08M COWRR: 0813 SRIM:

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (THIS REPORT) UNCLASSIFIED	21. NO. OF PAGES 23
	20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	22. PRICE

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by

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Division of Research and Laboratory Services
Engineering and Research Center
Denver, Colorado

SI METRIC

December 1984

UNITED STATES DEPARTMENT OF THE INTERIOR ★ BUREAU OF RECLAMATION

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

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INTRODUCTION

Inquiries were received concerning the adjustment of automatic compaction devices to achieve proper coverage by the rammer in the compaction mold. The devices used at the Engineering and Research Center laboratory. have traditionally been set at 8 blows per revolution, but available information on proper rotational adjustment was inconsistent. A study was made so that USBR (Bureau of Reclamation) automatic compaction devices could be adjusted consistently and correctly.

TERMINOLOGY

The term "automatic compaction device" refers to a mechanical device used to perform the laboratory (Proctor) compaction test by automatically applying blows from a 2.000-in (50.80-mm) diameter, 5.50-lbm (2.49-kg) rammer to the soil in a 4.000-in (101.6-mm) diameter compaction mold. One of two methods is used to obtain uniform coverage of the rammer on the surface of each soil specimen. The first method uses a fixed rammer location with a compaction mold that rotates either automatically or manually. The second method uses a fixed compaction mold with a rammer that rotates automatically. In both methods, the rammer impacts the soil around the periphery of the compaction mold. The automatic compaction device with the rotating rammer is described in this report; nevertheless, the concepts in this report dealing with uniform coverage apply to both types of devices.

In this report the phrase "blows per revolution" is used irrespective of the compaction method. Therefore, an automatic compaction device adjusted to produce 8 blows per revolution delivers 8 equally spaced blows (45 degrees of rotation between adjacent blows) around the periphery of the compaction mold in one 360-degree cycle for both types of device.

CONCLUSIONS

1. Automatic compaction device settings that result in approximately 6 to 10 blows per revolution yield test results within the precision and accuracy limitations prescribed by ASTM (American Society for Testing and Materials) for the laboratory compaction test.

2. A setting that yields 8.33 blows per revolution is relatively simple to obtain and results in an even 25 blows in three revolutions while not impacting the same location twice.

RECOMMENDATION

Automatic compaction devices should be adjusted to obtain 8.33 blows per revolution as described in this report.

EQUIPMENT

The equipment used in this study was the Rainhart Series 662 Automatic Tamper. This device is used in many USBR laboratories. It compacts soil in a 4.000-in (101.6-mm) diameter mold using a 2.000-in (50.80-mm) diameter rammer. The mold has a volume of 1/20 ft^3 (1416 cm^3), which is larger than the 1/30-ft^3 (944-cm^3) mold specified by ASTM [1]*. The 5.50-lbm (2.49-kg) rammer is dropped from a height of 18.0 in (457 mm), which is greater than the 12.0 in (305 mm) drop used by ASTM. The combined effect of a larger mold and a greater drop results in soil specimens subjected to the same input of energy as obtained with the ASTM procedure (12,375 ft-lbf/ft^3 (5.925×10^5 N·m/m^3)).

PREVIOUS RECOMMENDATIONS FROM VARIOUS SOURCES

As a first step in this investigation, a number of sources were consulted to determine existing recommendations regarding the adjustment of automatic compaction devices. We discovered that these recommendations were inconsistent and too general in nature.

ASTM standards [1] state (in both Designation D 698-78 "Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.59-kg) Rammer and 12-in. (305-mm) Drop," and Designation D 1557-78, "Moisture-Density Relations for Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop)": "The rammer shall operate mechanically in such a manner as to provide uniform and complete coverage of the specimen surface." No mention of the subject is made in ASTM D 2168-80, "Calibration of Mechanical Soil Compactors."

The Corps of Engineers [2] states "A mechanical compactor may be used as an alternative to the hand rammer provided its design permits each drop of the rammer to fall on a different area of the surface of the soil sample and the entire surface area to be uniformly compacted."

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* Numbers in brackets refer to entries in the bibliography.

Personnel with the Corps of Engineers' Waterways Experiment Station revealed that they typically set their automatic compaction devices for eight blows per revolution, but had not studied the adjustment of these devices.

The Operating and Service Manual for the Rainhart Series 662 Automatic Compactor [3] states "Generally, if the blows overlap about 20 percent to 25 percent, the resulting densities will approximate those obtained using proper manual compaction." However, contacts with the Rainhart Company indicated that their 20-to 25-percent overlap recommendation was based on a study performed by the Texas Highway Department using a 6-in-diameter mold and a "pie-shaped" rammer. Therefore, their recommendation is not directly applicable to the USBR procedure.

The USBR [4] recommends that "The blows shall be uniformly distributed over the surface of the layer." A check of several automatic compaction devices used in USBR laboratories revealed that the machines had been adjusted to deliver from 7 to 10 blows per revolution. The consensus was that 8 blows per revolution was the most commonly used setting. However, a setting of 8 blows per revolution does not strictly satisfy the requirement of "uniform coverage" because the rammer strikes in the same location on successive revolutions. This leaves areas around the periphery of the mold that are never directly impacted by the rammer.

TESTING PROGRAM

A limited testing program was planned to investigate three different soils and three different compactor settings.

The three soils selected for testing exhibited a fairly wide range of characteristics to represent varied field conditions. The characteristics of these soils are summarized in table 1.

Table 1. – Test soils.

Sample no.	23J-2	24G-103	55T-90
Laboratory classification	CL-ML	CL	CH
Typical name	Silty sand	Sandy clay	Fat clay
Liquid limit	25	27	68
Plasticity index	3	15	46
Percent sand	10	35	5
Percent fines	90	65	95
Specific gravity	2.66	2.68	2.70

The solution expected to achieve the best results was to adjust the automatic compaction devices to deliver 8.33 blows per revolution. This setting has several advantages over other possible

settings:

1. Three complete revolutions result in the required 25 blows. This permits simple adjustment of the compaction device. This adjustment is described later in this report.

2. During each revolution, blow locations are offset from the location of the blow in the previous revolution by ⅓ diameter of the rammer. This results in the most uniform coverage possible for 25 blows in a three-rotation cycle.

3. A setting of 8.33 blows per revolution is not greatly different from the settings commonly used in most laboratories.

In addition, a 6.25-blows per revolution setting was chosen because its deviation from 8.33 was approximately equal to that of the 6.25 setting.

The compaction apparatus used in this study was visually inspected and found to be in proper working order. The height of drop and weight of rammer were properly calibrated. The compactor was "warmed up" for 5 min before each test series. The soils were prepared and tested in accordance with *Earth Manual* Designation E-11 [4].

TEST RESULTS

A series of tests was performed on each soil using each of the rammer coverage settings. The results are shown in table 2 and on figures 1, 2, and 3. The appendix contains the test data sheets.

Table 2. – Maximum dry unit weight and optimum moisture content produced by various rammer coverage settings.

Sample No.	23J-2		24G-103		55T-90	
Blows per revolution	Maximum dry unit weight lbf/ft³	Optimum moisture content %	Maximum dry unit weight lbf/ft³	Optimum moisture content %	Maximum dry unit weight lbf/ft³	Optimum moisture content %
6.25	113.9	11.6	120.1	12.1	89.9	28.6
8.33	113.9	11.6	120.0	12.0	89.2	28.9
10.5	113.4	11.7	118.9	12.2	89.0	29.3
Maximum range of two results, expressed as percent of mean value*	0.4	0.9	1.0	1.7	1.0	2.4

* ASTM Designation D 698-78 [1] states that for single operator precision the acceptable range of any two results, expressed as a percentage of the mean value, should not exceed 1.9 and 9.5 for maximum unit weight and optimum moisture content, respectively.

Although the data are limited, the values of maximum dry unit weight and optimum moisture content for each soil are well within the limits of acceptable precision and accuracy described by ASTM D 698-78 [1]. Altering the number of blows per revolution (at least within the range between 6.25 and 10.5) seems to have little affect on the measured compaction characteristics of soil.

Nevertheless, we recommended that automatic compaction devices be adjusted to provide approximately 8.33 blows per revolution because this adjustment is relatively simple to make, is close to the settings already in use, and results in uniform coverage of the compaction specimen.

EQUIPMENT ADJUSTMENT

Adjustment of the Rainhart Series 662 Automatic Tamper to achieve 8.33 blows per revolution is relatively simple. The procedure is described below.

1. Place a rag, soil, or similar soft material in the mold and operate the machine for a few cycles. Always keep the switch in the "OFF" position while the machine is not in operation.
2. Remove the collar assembly.
3. Place a matchmark on the top edge of the mold and on the top of the rammer head (see fig. 4). Make sure these marks can be easily seen when the machine is not in operation. This may be accomplished by inserting enough soil or other soft material into the mold so that while the rammer is resting on the soft material, the top of the rammer will be at approximately the same elevation as the top of the mold.
4. Match the marks on the mold and the rammer head and operate the machine through one 25-blow cycle to check the rotation. At 8.33 blows per revolution and 25 blows per cycle, the rammer head should make three complete revolutions, after which the marks should again match, within a tolerance of ± 1 in (25 mm). See figure 4 for an example of how to measure this tolerance.
5. Reset the marks to match and repeat the test. If the test is within tolerance on three consecutive trials, the machine needs no adjustment. If the tolerance is not met, adjustment of the rotation is required.
6. The amount of overlapping of blows is controlled by the angle of the spacer rod (see fig. 5), which establishes the amount of rotation. Adjustment of the bottom of the spacer rod towards the column will increase the amount of overlap. Conversely, adjustment of the bottom of the spacer rod away from the column will decrease the amount of overlap. Some experimentation may be necessary to arrive at the correct adjustment. Loosen the

handnut at the bottom of the spacer rod and slide the rod towards or away from the column as necessary.

7. Tighten the handnut and repeat the test. Repeat this procedure until recommended tolerances are met.

The rotation of the rammer should be checked and reset, if necessary, each time the machine is calibrated.

BIBLIOGRAPHY

[1] *1984 Annual Book of ASTM Standards*, vol. 04.08, Soil and Rock; Building Stones, Designation D 698-78, "Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using a 5.5-lb (2.59-kg) Rammer and 12-in. (305-mm) Drop", American Society for Testing and Materials, 1984.

[2] *Engineering Manual EM 1110-2-1906, Laboratory Soils Testing,* Department of the Army, Office of the Chief of Engineers, Washington, D.C., 1970.

[3] Rainhart, *Operating and Service Manual, Automatic Tamper, Series 662,* 3rd ed.

[4] *Earth Manual,* 2d ed., Bureau of Reclamation, U.S. Government Printing Office, Washington, D.C., 1974.

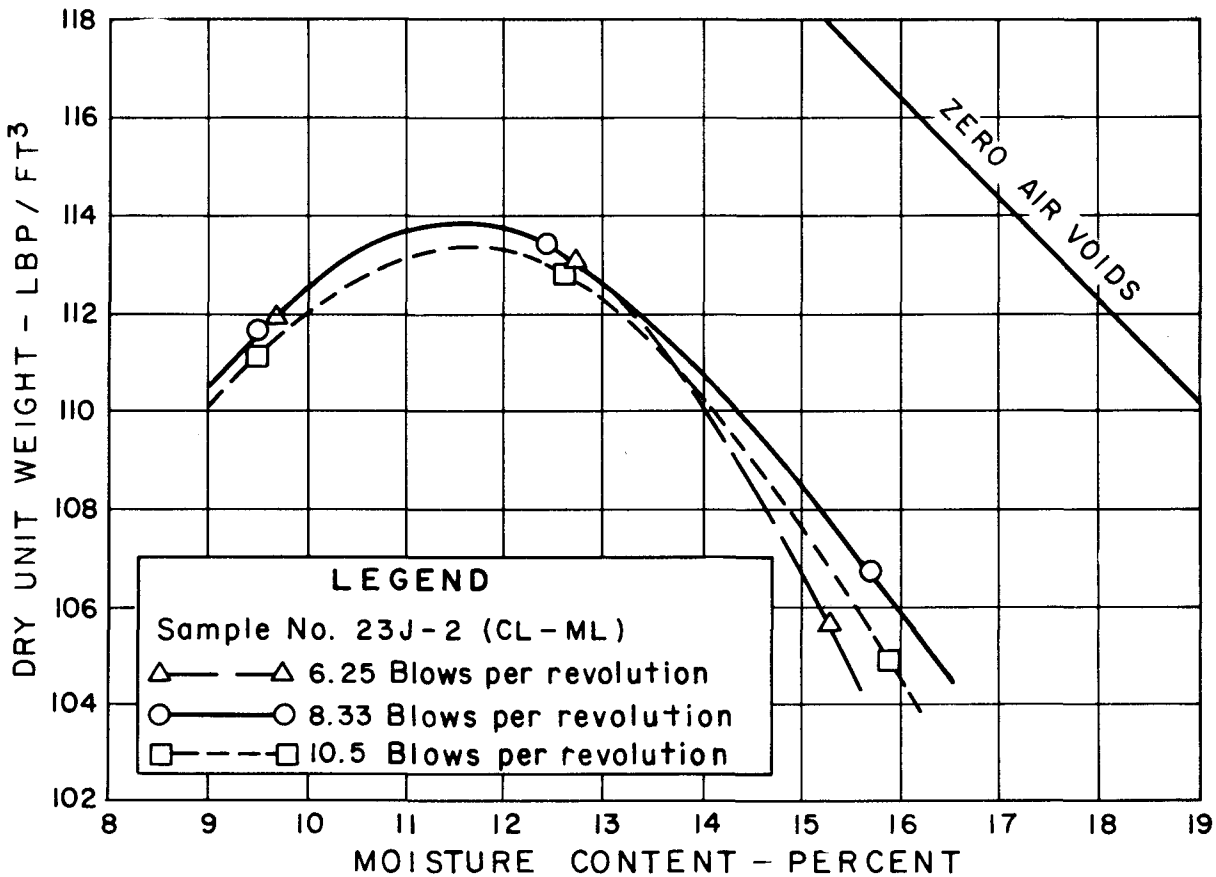


Figure 1. – Compaction curves for CL-ML soil.

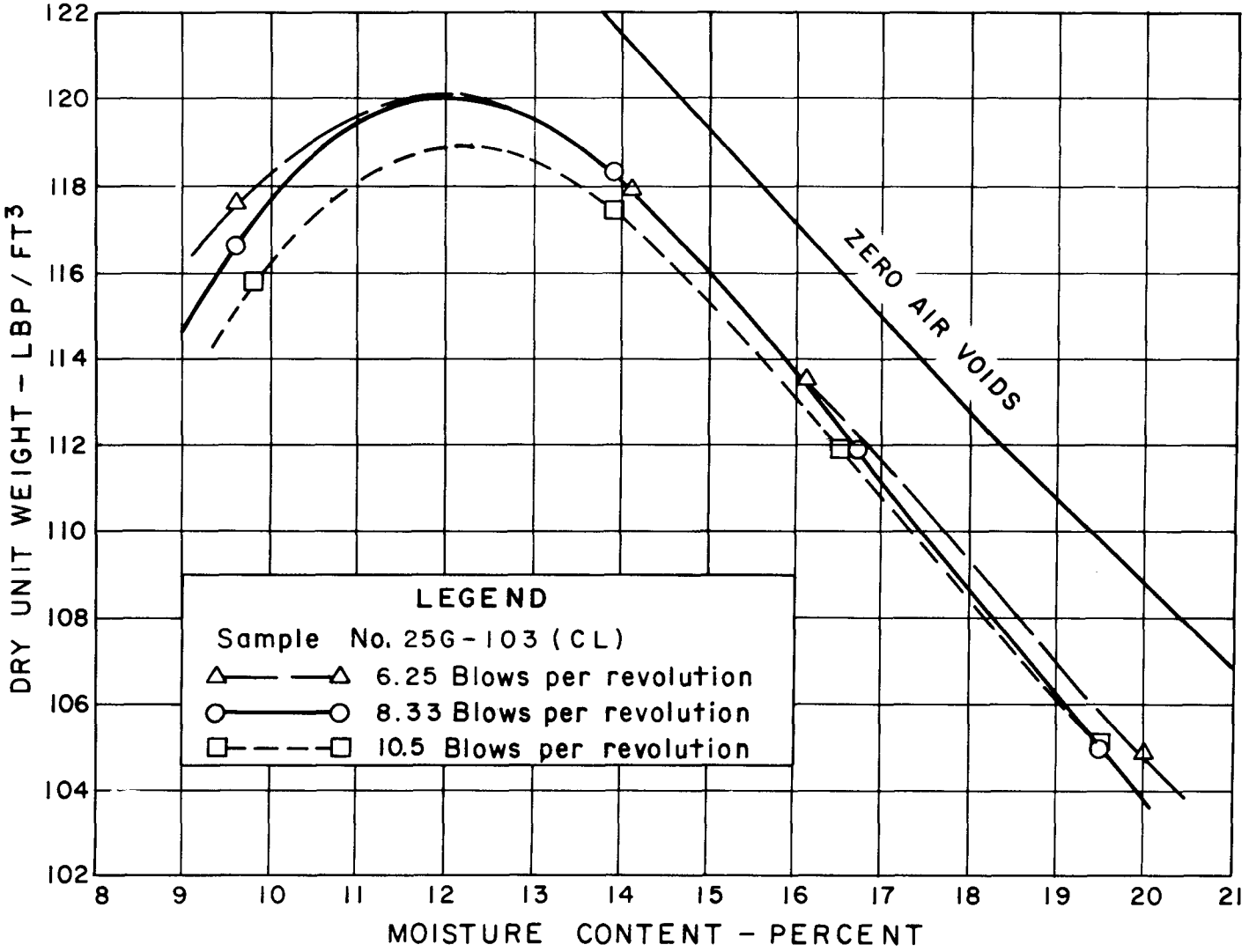
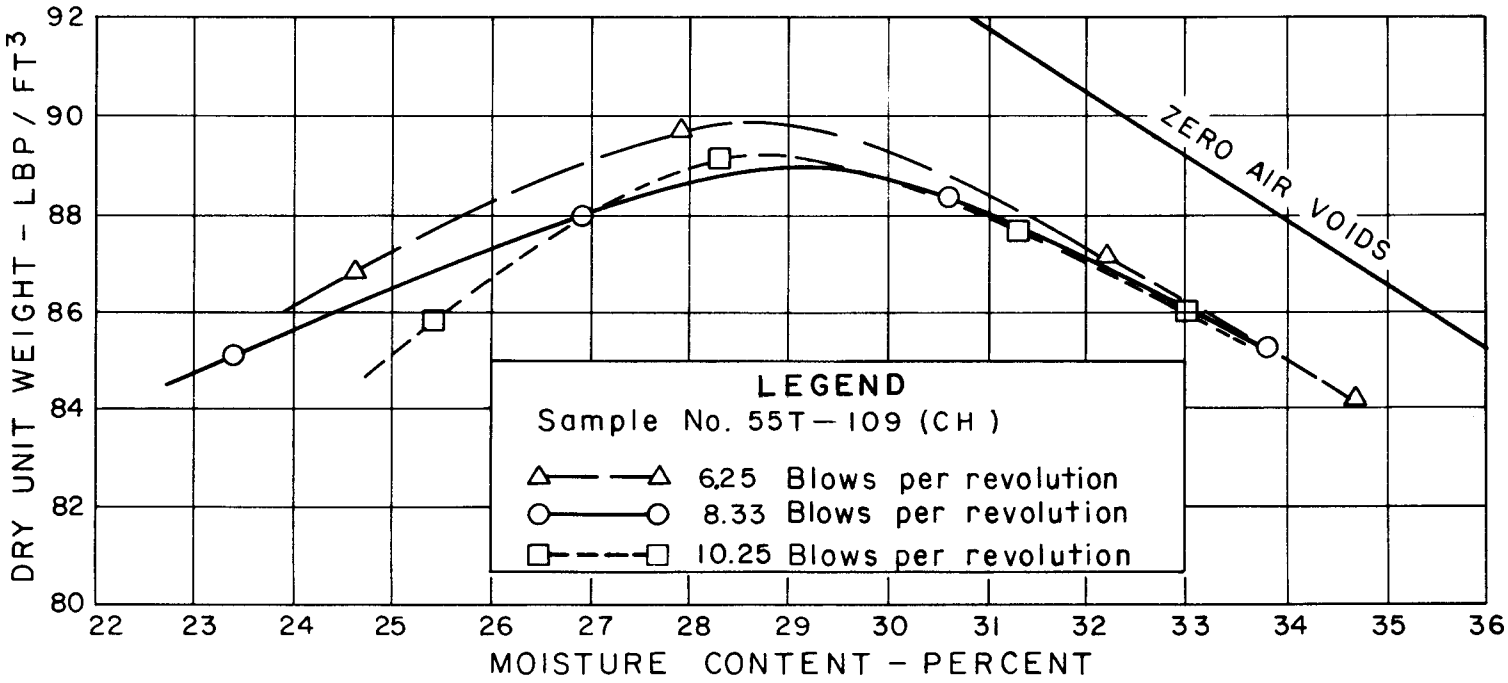


Figure 2. – Compaction curves for CL soil.


DRY UNIT WEIGHT - LBP / FT3
92
90
88
86
84
82
80
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
MOISTURE CONTENT - PERCENT
ZERO AIR VOIDS
LEGEND
Sample No. 55T-109 (CH)
6.25 Blows per revolution
8.33 Blows per revolution
10.25 Blows per revolution

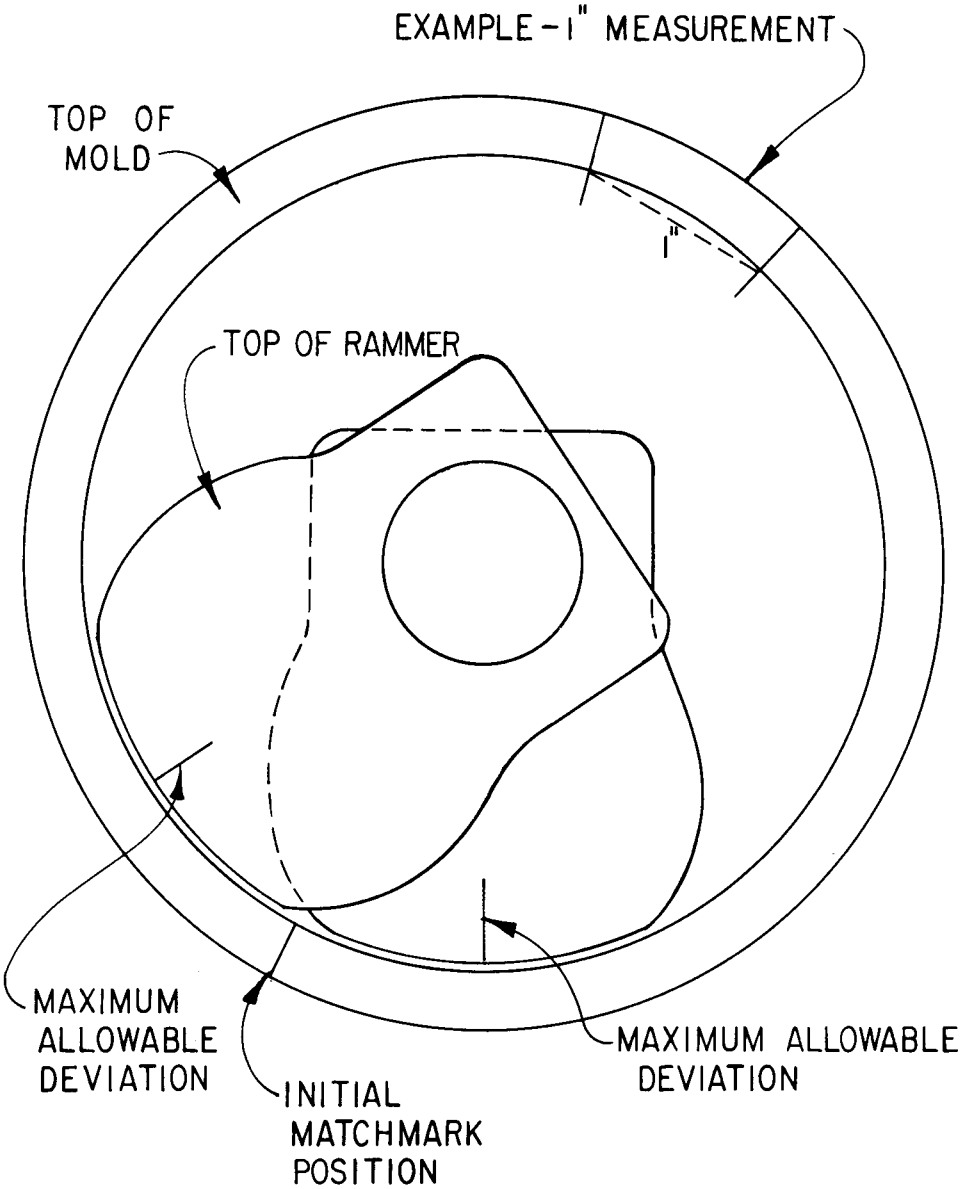
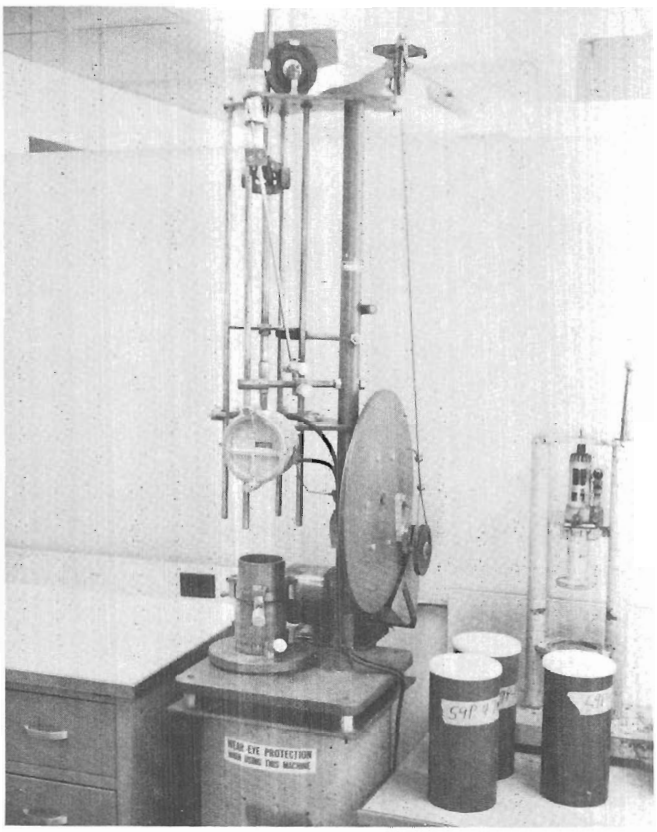


Figure 4. – Matchmark locations.



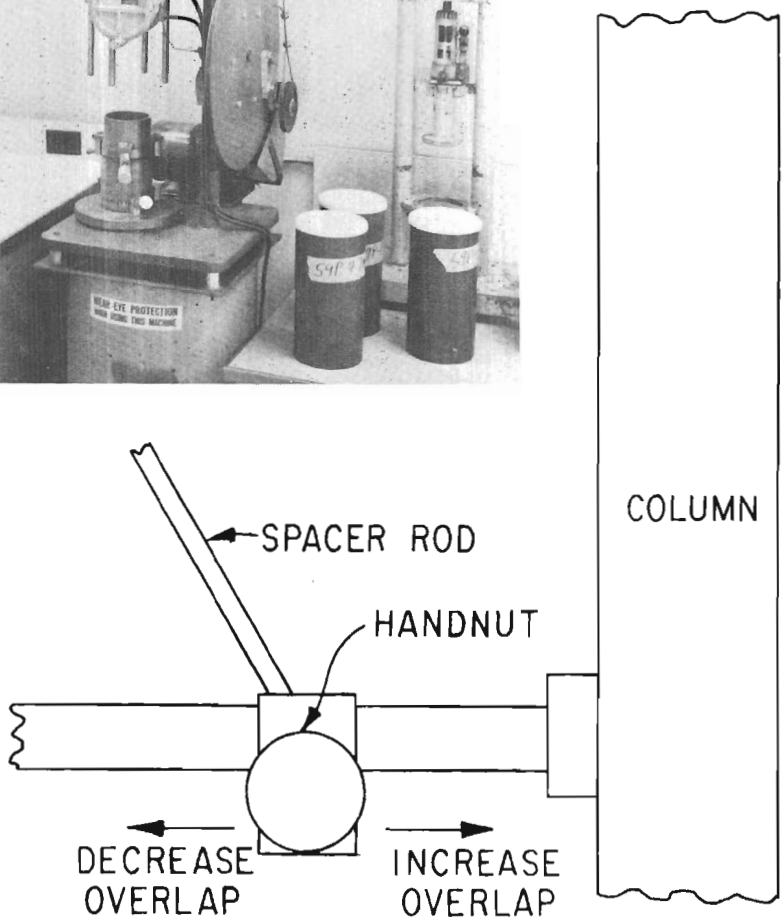


Figure 5. – Spacer rod adjustment and detail.

APPENDIX
Compaction Test Data Sheets

7-1391 (8-71)
Bureau of Reclamation

PROCTOR COMPACTION TEST

PROJECT _____ FEATURE _____ SAMPLE NO. 23J-2

TESTED BY V. GOLDSMITH COMPUTED BY V. GOLDSMITH CHECKED BY M. KNIPPS ✓ DATE 6/6/83

DEGREE OF COMPACTION, PROCTOR STANDARD [X] OR MODIFIED [ ] IF MODIFIED, SHOW RELATED INFORMATION AS FOLLOWS:

BLOWS PER LAYER _____ NO. OF LAYERS _____ HEIGHT OF DROP _____ in.

WEIGHT OF TAMPING ROD _____ lb VOLUME OF CYLINDER .04974 cu ft

TEST NO.	1	2	3	4	5	6	7	8
DENSITY DETERMINATIONS								
WATER ADDED (cc)		100	200	300				
WT CYL. + WET SOIL ~~(lb)~~ g		5827	5936	5809				
WT OF CYLINDER ~~(lb)~~ g		3059	3059	3059				
WT OF WET SOIL ~~(lb)~~ g		2768	2877	2750				
WT DENSITY (pcf)		122.7	127.5	121.9				
PENETRATION RESISTANCE DETERMINATIONS								
NEEDLE NO.								
AREA OF NEEDLE (sq in.)			N/A					
AVERAGE READING (lb)								
PENETRATION RESIST. (psi)								
WATER CONTENT DETERMINATIONS								
DISH NO.		30	202	96				
WT DISH + WET SOIL		619.0	621.5	539.0				
WT DISH + DRY SOIL		577.7	570.5	488.2				
WEIGHT OF DISH		153.6	169.9	157.2				
WEIGHT OF WATER		41.3	51.0	50.8				
WEIGHT OF DRY SOIL		424.1	400.6	331.0				
WATER CONT. (% DRY WT)		9.7	12.7	15.3				
DRY DENSITY (pcf)		111.9	113.1	105.7				

QUESTIONS TO ANSWER FROM OBSERVATIONS BY OPERATORS DURING TEST

1. HOW FAST DOES SAMPLE ABSORB WATER? FAST _____ MEDIUM _____ SLOW _____
2. IS DIFFICULTY ENCOUNTERED IN MIXING WATER WITH SOIL? _____
3. ARE PENETRATION NEEDLE READINGS RELIABLE? _____
4. AT WHAT TEST NOS. IS SAMPLE CRUMBLY? _____ FIRM? _____ SOFT? _____
5. WAS BLEEDING NOTICED DURING TEST? _____ IF SO, WHAT TEST NOS.? _____
6. AT WHAT TEST NOS. IS SAMPLE SPONGY? _____
7. OTHER COMMENTS 6.25 BLOWS PER REVOLUTION

* U. S. GPO: 1976—777-007/1222 Region No. 8

7-1391 (8-71)
Bureau of Reclamation

PROCTOR COMPACTION TEST

PROJECT _____ FEATURE _____ SAMPLE NO. 23J-2

TESTED BY V. GOLDSMITH COMPUTED BY V. GOLDSMITH CHECKED BY M. KUIPERS DATE 6/6/83

DEGREE OF COMPACTION, PROCTOR STANDARD [X] OR MODIFIED [ ] IF MODIFIED, SHOW RELATED INFORMATION AS FOLLOWS:

BLOWS PER LAYER _____ NO. OF LAYERS _____ HEIGHT OF DROP _____ in.

WEIGHT OF TAMPING ROD _____ lb VOLUME OF CYLINDER .04974 cu ft

TEST NO.	1	2	3	4	5	6	7	8
DENSITY DETERMINATIONS								
WATER ADDED (cc)		100	200	300				
WT CYL. + WET SOIL ~~(lb)~~ g		5816	5936	5844				
WT OF CYLINDER ~~(lb)~~ g		3059	3059	3059				
WT OF WET SOIL ~~(lb)~~ g		2757	2877	2785				
WT DENSITY (pcf)		122.2	127.5	123.4				
PENETRATION RESISTANCE DETERMINATIONS								
NEEDLE NO.								
AREA OF NEEDLE (sq in.)			N/A					
AVERAGE READING (lb)								
PENETRATION RESIST. (psi)								
WATER CONTENT DETERMINATIONS								
DISH NO.		153	181	L14				
WT DISH + WET SOIL		556.8	543.0	486.0				
WT DISH + DRY SOIL		522.3	501.2	437.2				
WEIGHT OF DISH		161.0	165.3	126.1				
WEIGHT OF WATER		34.5	41.8	48.8				
WEIGHT OF DRY SOIL		361.3	335.9	311.1				
WATER CONT. (% DRY WT)		9.5	12.4	15.7				
DRY DENSITY (pcf)		111.6	113.4	106.7				

QUESTIONS TO ANSWER FROM OBSERVATIONS BY OPERATORS DURING TEST

1. HOW FAST DOES SAMPLE ABSORB WATER? FAST _____ MEDIUM _____ SLOW _____
2. IS DIFFICULTY ENCOUNTERED IN MIXING WATER WITH SOIL? _____
3. ARE PENETRATION NEEDLE READINGS RELIABLE? _____
4. AT WHAT TEST NOS. IS SAMPLE CRUMBLY? _____ FIRM? _____ SOFT? _____
5. WAS BLEEDING NOTICED DURING TEST? _____ IF SO, WHAT TEST NOS.? _____
6. AT WHAT TEST NOS. IS SAMPLE SPONGY? _____
7. OTHER COMMENTS 8.33 BLOWS PER REVOLUTION

* U. S. GPO: 1976—777-007/1222 Region No. 8

7-1391 (8-71)
Bureau of Reclamation

PROCTOR COMPACTION TEST

PROJECT _____ FEATURE _____ SAMPLE NO. 23J-2

TESTED BY V. GOLDSMITH COMPUTED BY V. GOLDSMITH CHECKED BY M. KNIPPS DATE 6/6/83

DEGREE OF COMPACTION, PROCTOR STANDARD [X] OR MODIFIED [ ] IF MODIFIED, SHOW RELATED INFORMATION AS FOLLOWS:

BLOWS PER LAYER _____ NO. OF LAYERS _____ HEIGHT OF DROP _____ in.

WEIGHT OF TAMPING ROD _____ lb VOLUME OF CYLINDER .04974 cu ft

TEST NO.	1	2	3	4	5	6	7	8
DENSITY DETERMINATIONS								
WATER ADDED (cc)		100	200	300				
WT CYL. + WET SOIL ~~(lb)~~ g		5803	5924	5802				
WT OF CYLINDER ~~(lb)~~ g		3059	3059	3059				
WT OF WET SOIL ~~(lb)~~ g		2744	2865	2743				
WT DENSITY (pcf)		121.6	127.0	121.6				
PENETRATION RESISTANCE DETERMINATIONS								
NEEDLE NO.								
AREA OF NEEDLE (sq in.)			N/A					
AVERAGE READING (lb)								
PENETRATION RESIST. (psi)								
WATER CONTENT DETERMINATIONS								
DISH NO.		59	17	220				
WT DISH + WET SOIL		552.0	596.8	586.0				
WT DISH + DRY SOIL		516.9	545.0	527.4				
WEIGHT OF DISH		141.6	133.8	158.2				
WEIGHT OF WATER		35.1	51.8	58.6				
WEIGHT OF DRY SOIL		370.8	411.2	369.2				
WATER CONT. (% DRY WT)		9.5	12.6	15.9				
DRY DENSITY (pcf)		111.1	112.8	104.9				

QUESTIONS TO ANSWER FROM OBSERVATIONS BY OPERATORS DURING TEST

1. HOW FAST DOES SAMPLE ABSORB WATER? FAST _____ MEDIUM _____ SLOW _____
2. IS DIFFICULTY ENCOUNTERED IN MIXING WATER WITH SOIL? _____
3. ARE PENETRATION NEEDLE READINGS RELIABLE? _____
4. AT WHAT TEST NOS. IS SAMPLE CRUMBLY? _____ FIRM? _____ SOFT? _____
5. WAS BLEEDING NOTICED DURING TEST? _____ IF SO, WHAT TEST NOS.? _____
6. AT WHAT TEST NOS. IS SAMPLE SPONGY? _____
7. OTHER COMMENTS 10.5 BLOWS PER REVOLUTION

* U. S. GPO: 1976—777-007/1222 Region No. 8

7-1391 (8-71)
Bureau of Reclamation

PROCTOR COMPACTION TEST

PROJECT _____ FEATURE _____ SAMPLE NO. 296-103

TESTED BY V. GOLDSMITH COMPUTED BY V. GOLDSMITH CHECKED BY M. KNIPPS DATE 6/6/83

DEGREE OF COMPACTION, PROCTOR STANDARD [X] OR MODIFIED [ ] IF MODIFIED, SHOW RELATED INFORMATION AS FOLLOWS:

BLOWS PER LAYER _____ NO. OF LAYERS _____ HEIGHT OF DROP _____ in.

WEIGHT OF TAMPING ROD _____ lb VOLUME OF CYLINDER .04974 cu ft

TEST NO.	1	2	3	4	5	6	7	8
DENSITY DETERMINATIONS								
WATER ADDED (cc)		300	400	500	600			
WT CYL. + WET SOIL ~~(lb)~~ g		5967	6093	6032	5900			
WT OF CYLINDER ~~(lb)~~ g		3059	3059	3059	3059			
WT OF WET SOIL ~~(lb)~~ g		2908	3034	2973	2841			
WT DENSITY (pcf)		128.9	134.5	131.8	125.9			
PENETRATION RESISTANCE DETERMINATIONS								
NEEDLE NO.								
AREA OF NEEDLE (sq in.)			N/A					
AVERAGE READING (lb)								
PENETRATION RESIST. (psi)								
WATER CONTENT DETERMINATIONS								
DISH NO.		50	L14	220	59			
WT DISH + WET SOIL		519.6	588.6	582.8	587.7			
WT DISH + DRY SOIL		489.0	531.6	524.0	514.0			
WEIGHT OF DISH		170.8	126.1	158.2	146.1			
WEIGHT OF WATER		30.6	57.0	58.8	73.7			
WEIGHT OF DRY SOIL		318.2	405.5	365.8	367.9			
WATER CONT. (% DRY WT)		9.6	14.1	16.1	20.0			
DRY DENSITY (pcf)		117.6	117.9	113.5	104.9			

QUESTIONS TO ANSWER FROM OBSERVATIONS BY OPERATORS DURING TEST

1. HOW FAST DOES SAMPLE ABSORB WATER? FAST _____ MEDIUM _____ SLOW _____
2. IS DIFFICULTY ENCOUNTERED IN MIXING WATER WITH SOIL? _____
3. ARE PENETRATION NEEDLE READINGS RELIABLE? _____
4. AT WHAT TEST NOS. IS SAMPLE CRUMBLY? _____ FIRM? _____ SOFT? _____
5. WAS BLEEDING NOTICED DURING TEST? _____ IF SO, WHAT TEST NOS.? _____
6. AT WHAT TEST NOS. IS SAMPLE SPONGY? _____
7. OTHER COMMENTS 6.25 BLOWS PER REVOLUTION

* U. S. GPO: 1976—777-007/1222 Region No. 8

7-1391 (8-71)
Bureau of Reclamation

PROCTOR COMPACTION TEST

PROJECT _____ FEATURE _____ SAMPLE NO. 246-103

TESTED BY V. GOLDSMITH COMPUTED BY V. GOLDSMITH CHECKED BY M. KNIPPS DATE 6/6/83

DEGREE OF COMPACTION, PROCTOR STANDARD [X] OR MODIFIED [ ] IF MODIFIED, SHOW RELATED INFORMATION AS FOLLOWS:

BLOWS PER LAYER _____ NO. OF LAYERS _____ HEIGHT OF DROP _____ in.

WEIGHT OF TAMPING ROD _____ lb VOLUME OF CYLINDER .04974 cu ft

TEST NO.	1	2	3	4	5	6	7	8
DENSITY DETERMINATIONS								
WATER ADDED (cc)		300	400	500	600			
WT CYL. + WET SOIL ~~(lb)~~ g		5943	6099	6004	5891			
WT OF CYLINDER ~~(lb)~~ g		3059	3059	3059	3059			
WT OF WET SOIL ~~(lb)~~ g		2884	3040	2945	2832			
WT DENSITY (pcf)		127.8	134.7	130.5	125.5			
PENETRATION RESISTANCE DETERMINATIONS								
NEEDLE NO.								
AREA OF NEEDLE (sq in.)			N/A					
AVERAGE READING (lb)								
PENETRATION RESIST. (psi)								
WATER CONTENT DETERMINATIONS								
DISH NO.		153	17	153	96			
WT DISH + WET SOIL		581.6	597.1	601.4	619.5			
WT DISH + DRY SOIL		544.6	540.6	538.4	544.0			
WEIGHT OF DISH		160.9	133.8	160.8	157.1			
WEIGHT OF WATER		37.0	56.5	63.0	75.5			
WEIGHT OF DRY SOIL		383.7	406.8	377.6	386.9			
WATER CONT. (% DRY WT)		9.6	13.9	16.7	19.5			
DRY DENSITY (pcf)		116.6	118.3	111.8	105.0			

QUESTIONS TO ANSWER FROM OBSERVATIONS BY OPERATORS DURING TEST

1. HOW FAST DOES SAMPLE ABSORB WATER? FAST _____ MEDIUM _____ SLOW _____
2. IS DIFFICULTY ENCOUNTERED IN MIXING WATER WITH SOIL? _____
3. ARE PENETRATION NEEDLE READINGS RELIABLE? _____
4. AT WHAT TEST NOS. IS SAMPLE CRUMBLY? _____ FIRM? _____ SOFT? _____
5. WAS BLEEDING NOTICED DURING TEST? _____ IF SO, WHAT TEST NOS.? _____
6. AT WHAT TEST NOS. IS SAMPLE SPONGY? _____
7. OTHER COMMENTS 8.33 BLOWS PER REVOLUTION

* U. S. GPO: 1976—777-007/1222 Region No. 8

7-1391 (8-71)
Bureau of Reclamation

PROCTOR COMPACTION TEST

PROJECT _____ FEATURE _____ SAMPLE NO. 246-103

TESTED BY V. GOLDSMITH COMPUTED BY V. GOLDSMITH CHECKED BY M. Kruppo DATE 6/6/83

DEGREE OF COMPACTION, PROCTOR STANDARD [X] OR MODIFIED [ ] IF MODIFIED, SHOW RELATED INFORMATION AS FOLLOWS:

BLOWS PER LAYER _____ NO. OF LAYERS _____ HEIGHT OF DROP _____ in.

WEIGHT OF TAMPING ROD _____ lb VOLUME OF CYLINDER .04974 cu ft

TEST NO.	1	2	3	4	5	6	7	8
DENSITY DETERMINATIONS								
WATER ADDED (cc)		300	400	500	600			
WT CYL.+ WET SOIL ~~(lb)~~ g		5928	6076	6000	5893			
WT OF CYLINDER ~~(lb)~~ g		3059	3059	3059	3059			
WT OF WET SOIL ~~(lb)~~ g		2869	3017	2941	2834			
WT DENSITY (pcf)		127.2	133.7	130.4	125.6			
PENETRATION RESISTANCE DETERMINATIONS								
NEEDLE NO.								
AREA OF NEEDLE (sq in.)			N/A					
AVERAGE READING (lb)								
PENETRATION RESIST. (psi)								
WATER CONTENT DETERMINATIONS								
DISH NO.		30	202	181	31			
WT DISH + WET SOIL		610.2	637.1	641.1	640.3			
WT DISH + DRY SOIL		569.7	580.2	573.7	561.0			
WEIGHT OF DISH		153.7	170.4	165.5	153.8			
WEIGHT OF WATER		40.5	56.9	67.4	79.3			
WEIGHT OF DRY SOIL		414.0	409.8	408.2	407.2			
WATER CONT. (% DRY WT)		9.8	13.9	16.5	19.5			
DRY DENSITY (pcf)		115.8	117.4	111.9	105.1			

QUESTIONS TO ANSWER FROM OBSERVATIONS BY OPERATORS DURING TEST

1. HOW FAST DOES SAMPLE ABSORB WATER? FAST _____ MEDIUM _____ SLOW _____
2. IS DIFFICULTY ENCOUNTERED IN MIXING WATER WITH SOIL? _____
3. ARE PENETRATION NEEDLE READINGS RELIABLE? _____
4. AT WHAT TEST NOS. IS SAMPLE CRUMBLY? _____ FIRM? _____ SOFT? _____
5. WAS BLEEDING NOTICED DURING TEST? _____ IF SO, WHAT TEST NOS.? _____
6. AT WHAT TEST NOS. IS SAMPLE SPONGY? _____
7. OTHER COMMENTS 10.5 BLOWS PER REVOLUTION

* U. S. GPO: 1976—777-007/1222 Region No. 8

7-1391 (8-71)
Bureau of Reclamation

PROCTOR COMPACTION TEST

PROJECT _____ FEATURE _____ SAMPLE NO. SST-90

TESTED BY V. GOLDSMITH COMPUTED BY V. GOLDSMITH CHECKED BY M. KNIPPS DATE 6/6/83

DEGREE OF COMPACTION, PROCTOR STANDARD [X] OR MODIFIED [ ] IF MODIFIED, SHOW RELATED INFORMATION AS FOLLOWS:

BLOWS PER LAYER _____ NO. OF LAYERS _____ HEIGHT OF DROP _____ in.

WEIGHT OF TAMPING ROD _____ lb VOLUME OF CYLINDER .04974 cu ft

TEST NO.	1	2	3	4	5	6	7	8
DENSITY DETERMINATIONS								
WATER ADDED (cc)		600	700	800	900			
WT CYL. + WET SOIL ~~(lb)~~ g		5503	5646	5655	5618			
WT OF CYLINDER ~~(lb)~~ g		3059	3059	3059	3059			
WT OF WET SOIL ~~(lb)~~ g		2444	2587	2596	2559			
WT DENSITY (pcf)		108.3	114.7	115.1	113.4			
PENETRATION RESISTANCE DETERMINATIONS								
NEEDLE NO.								
AREA OF NEEDLE (sq in.)			N/A					
AVERAGE READING (lb)								
PENETRATION RESIST. (psi)								
WATER CONTENT DETERMINATIONS								
DISH NO.		203	96	181	50			
WT DISH + WET SOIL		595.1	592.8	563.0	589.9			
WT DISH + DRY SOIL		469.8	497.8	466.2	481.8			
WEIGHT OF DISH		163.7	157.1	165.5	170.5			
WEIGHT OF WATER		75.3	95.0	96.8	108.1			
WEIGHT OF DRY SOIL		306.1	340.7	300.7	311.3			
WATER CONT. (% DRY WT)		24.6	27.9	32.2	34.7			
DRY DENSITY (pcf)		86.9	89.7	87.1	84.2			

QUESTIONS TO ANSWER FROM OBSERVATIONS BY OPERATORS DURING TEST

1. HOW FAST DOES SAMPLE ABSORB WATER? FAST _____ MEDIUM _____ SLOW _____
2. IS DIFFICULTY ENCOUNTERED IN MIXING WATER WITH SOIL? _____
3. ARE PENETRATION NEEDLE READINGS RELIABLE? _____
4. AT WHAT TEST NOS. IS SAMPLE CRUMBLY? _____ FIRM? _____ SOFT? _____
5. WAS BLEEDING NOTICED DURING TEST? _____ IF SO, WHAT TEST NOS.? _____
6. AT WHAT TEST NOS. IS SAMPLE SPONGY? _____
7. OTHER COMMENTS 6.25 BLOWS/REVOLUTION

* U. S. GPO. 1976—777-007/1222 Region No. 8

Mission of the Bureau of Reclamation

The Bureau of Reclamation of the U.S. Department of the Interior is responsible for the development and conservation of the Nation's water resources in the Western United States.

The Bureau's original purpose "to provide for the reclamation of arid and semiarid lands in the West" today covers a wide range of interrelated functions. These include providing municipal and industrial water supplies; hydroelectric power generation; irrigation water for agriculture; water quality improvement; flood control; river navigation; river regulation and control; fish and wildlife enhancement; outdoor recreation; and research on water-related design, construction, materials, atmospheric management, and wind and solar power.

Bureau programs most frequently are the result of close cooperation with the U.S. Congress, other Federal agencies, States, local governments, academic institutions, water-user organizations, and other concerned groups.

A free pamphlet is available from the Bureau entitled "Publications for Sale." It describes some of the technical publications currently available, their cost, and how to order them. The pamphlet can be obtained upon request from the Bureau of Reclamation, Attn D-922, P O Box 25007, Denver Federal Center, Denver CO 80225-0007.