Technical Report Documentation Page

1. REPORT No.
CA-DOT-TL-2167-1-76-36

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE
Water-Holding Capacity For Hydromulch

5. REPORT DATE
June 1976

6. PERFORMING ORGANIZATION

7. AUTHOR(S)
Thomas Hoover

8. PERFORMING ORGANIZATION REPORT No.
19203-632167

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Office of Transportation Laboratory
California Department of Transportation
Sacramento, California 95819

10. WORK UNIT No.

11. CONTRACT OR GRANT No.
F-5-17

12. SPONSORING AGENCY NAME AND ADDRESS
California Department of Transportation
Sacramento, California

13. TYPE OF REPORT & PERIOD COVERED
Final

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

It was the intent of this project to develop a reliable test for evaluating the water-holding capacity of various types of hydro-mulch fibers. This was accomplished by refining an initial method which was a synthesis of the methods used by three major producer/testers of hydromulch fiber. Both the initial and resultant methods are described as well as the process of refinement .

17. KEYWORDS
Mulch, water holding erosion control, seeding, hydromulching

18. No. OF PAGES:
30

19. DRI WEBSITE LINK
http://www.dot.ca.gov/hq/research/researchreports/1976-1977/76-36.pdf

20. FILE NAME
76-36.pdf

DIVISION OF STRUCTURES AND ENGINEERING SERVICES

TRANSPORTATION LABORATORY

RESEARCH REPORT

Water-Holding Capacity for Hydromulch

FINAL REPORT

CA-DOT-TL-2167-1-76-36

76-36

JUNE 1976

Prepared in Cooperation with the U.S. Department of Transportation, Federal Highway Administration

Caltrans

CALIFORNIA DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
CA-DOT-TL-2167-1-76-36		

4. TITLE AND SUBTITLE	5. REPORT DATE
WATER-HOLDING CAPACITY FOR HYDROMULCH	June 1976
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Thomas Hoover	19203-632167
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. WORK UNIT NO.
Office of Transportation Laboratory California Department of Transportation Sacramento, California 95819	11. CONTRACT OR GRANT NO. F-5-17
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT & PERIOD COVERED
California Department of Transportation Sacramento, California 95807	Final
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This study was conducted in cooperation with the U. S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

It was the intent of this project to develop a reliable test for evaluating the water-holding capacity of various types of hydro-mulch fibers. This was accomplished by refining an initial method which was a synthesis of the methods used by three major producer/testers of hydromulch fiber. Both the initial and resultant methods are described as well as the process of refinement.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Mulch, water holding erosion control, seeding, hydromulching.	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161.

19. SECURITY CLASSIF. (OF THIS REPORT)	20. SECURITY CLASSIF. (OF THIS PAGE)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified		

HMRT – 1242 (ORIG. 9/72)

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF STRUCTURES & ENGINEERING SERVICES
OFFICE OF TRANSPORTATION LABORATORY

June 1976

FHWA No. F-5-17
TL No. 632167

Mr. C. E. Forbes
Chief Engineer

Dear Sir:

I have approved and now submit for your information this final research project report titled:

WATER-HOLDING CAPACITY FOR HYDROMULCH

Study made by . . . . Geotechnical Branch

Under the Supervision of . . . . Raymond A. Forsyth

Co-Principal Investigators . . . . Marvin L. McCauley
Byron Works and
Thomas P. Hoover

Report Prepared by . . . . Thomas P. Hoover

Very truly yours,

George A Hill

GEORGE A. HILL
Chief, Office of Transportation Laboratory

Attachment

TPH:lrb

ACKNOWLEDGEMENTS

The author thanks the many people of the Transportation Laboratory and the Districts 1, 2, and 3 Materials Laboratories for their cooperation and work.

This research was done in cooperation with the U.S. Department of Transportation, Federal Program No. F-5-17.

TABLE OF CONTENTS

I. INTRODUCTION

No accepted standard method for evaluating the water-holding capacity of hydromulch fibers exists. Therefore, no requirements for this characteristic of hydromulch fiber have been established and the quantitative comparison of different hydromulch fibers is not made.

The report presents the results of a study with the objective of developing a procedure for determining the water-holding capacity of hydromulch fibers.

The increased interest in water-holding capacity of hydromulch fibers is a result of environmental requirements for erosion control and a growing demand for reestablishment of vegetation in disturbed areas, even though these areas may not be especially erodible. Revegetation requires the use of many techniques of landscaping and planting, including direct seeding which requires mulch to retain the seed and fertilizer, and protect seed and roots of young plants from excessive heat, drying, and cold. The establishment of the young plants, which are usually grasses or legumes, is directly affected by the water-holding capacity of hydromulch fiber when applied over the seeds.

In the past two years, the Office of Construction of Caltrans has been accepting most contractor-supplied hydromulch fibers. Ambient moisture content is measured for payment purposes, however, water-holding capacity is not. Since there is no current requirement for water-holding capacity, an ineffective product has been used on several contracts because of a lower initial cost. This product failed to retain adquate moisture for high vegetation establishment, a necessity for satisfactory erosion control. Hence, a need to establish water-holding capacity requirements was generated.

A preliminary search of published literature concerning a test method in this field proved unavailing.

CONCLUSIONS AND RECOMMENDATIONS

The attached test method, Appendix A, permits measurement of the water holding capacity of hydromulch fiber. Due to the inherent variability of the product, this test should be run 3 times on 3 distinct samples with the average value being designated as the water holding capacity.

One-way variance analysis of 6 factors (soak time, agitation, drain time, drying time, mulch type, and operator variation) which might affect the test results showed no significant variations when using the proposed method if drying time exceeds 4 hours.

Based on the result of this study it is recommended that the proposed method be used as a standard test method and be utilized to determine a minimum water-holding capacity for hydromulch fibers.

III. IMPLEMENTATION

This test method can be used immediately by Caltrans districts to determine water-holding capacities of hydromulch fibers currently being used. It can also be used by Caltrans to develop water-holding capacity specifications for future work.

IV. METHOD

No published literature was found for a test method in this field. The Translab Library, California State Library and the University of California at Davis Library were consulted. Neither the American Society for Testing and Materials (ASTM) nor the Technical Association of the Pulp and Paper Industry (TAPPI) list this type of test. U.S. Testing, Inc., of Los Angeles, California; Weyerhauser Co., Research Division, of Longview, Washington; and Conwed Corporation of St. Paul, Minnesota, were contacted because they market, or test for the marketing companies, this type of product. They were unaware of any standard methods of testing this product for water-holding capacity.

The above organizations provided copies of their procedures for testing water-holding capacity. These procedures were combined and modified by translab personnel and resulted in the method outlined in Appendix B.

This initial method was evaluated in our Laboratory before extensive field testing was begun. Four of the 6 pertinent parameters were evaluated. The first was soaking time required for saturation without agitation. A range of from 5 to 30 minutes was investigated.

The second was agitation and its duration during soaking. The range of investigation for agitation duration was 3 to 10 minutes.

The third to be considered was the length of time allowed for the slurry of fiber and water to drain before a saturated sample is extracted. Drain time ranged from 60 to 300 seconds.

The fourth parameter was drying time. It varied from 2 to 16 hours.

The test method and its capabilities were statistically evaluated. Four one-way analyses of variance were made using the following parameters: Soak time, soak and stir time, drain time and drying time (see Appendicies C through F). Of these the last factor proved significant. Apparently, 4 hours is insufficient for full drying to occur.

Interactions were not studied in this experiment.

It was also determined that results varied due to compression of fibers when a saturated sample was scooped from the drain screen. In an effort to reduce this influence, the fibers were poured directly into a 3-inch No. 30 sieve. The sample was then weighed and the net sample weight recorded. This attempt to decrease the variation was not successful (see Appendix G). The method was, however, modified to decrease the variance resulting from obtaining the wet sample (see photos, Appendix A).

The proposed method was then used to evaluate the water-holding capacity of various types of mulches. Results of these tests revealed significant differences (see Appendix H).

The proposed test method, was then used on a single brand of product a total of 46 times by 9 different technicians with a resulting F ratio of 1.99 which is well within the limits which can be attributed to chance variations (see Appendix I). Operator differences should have little effect on the test results, provided care is taken not to squeeze water from the sample when removing a representative sample from the drain sieve.

V. PROBLEMS ENCOUNTERED

The first problem encountered involved the technique used to obtain a wet sample from the drain screen. It was found that any method other than one single scooping (see photos, Appendix A) of the sample introduces error. If the first sample weight is outside of the allowable range for wet sample weight, attempts to correct the weight by the addition or removal of material will introduce variation. The additional squeezing associated with multiple handling alters the moisture content. If fiber is added to the weighed sample the added fiber has a lower water content and thus yields a lower overall water-holding capacity. If fiber is removed from the sample pan it leaves excess water in the remaining sample thus yielding a higher water-holding capacity.

These variations attributable to sample size adjustment are eliminated by taking the sample in a single scooping with a wide range of acceptable wet sample weights.

The use of additional screens for catching the fiber sample to be weighed introduces errors due to random water retention within the weighed screens (see Appendix G).

Many experienced technicians fail to collect the appropriate apparatus and properly prepare for the first run of new test procedures. Because of this lack of preparedness not all data collected was used in the evaluation of the test method.

The author was present at all first time performances of the test and thus rejected those where the method was altered due to lack of preparation.

Other identified sources of variation encountered were: 1) the random adjustment of fiber mound by the technician to a smooth shape, and 2) a faulty screen. All of the data produced with the random shaping was discarded since there was no record of the times when excess squeezing occurred. The data produced with the defective screen was also rejected.

When the operator observed, and noted on his work sheet any testing difficulties that data was rejected. For example, when operator 3 made his 4th run he noted a partial plugging of the screen, thus reducing drainage. That individual test was rejected. As a result operator 3 shows a total of only 7 runs rather than the 8 actually performed.

APPENDIX A

MODIFIED PROPOSED TEST METHOD - WATER-HOLDING CAPACITY FOR HYDROMULCH FIBER

Materials and Apparatus Required

1. Scale 0-1,000 grams ± .5 grams
2. 3,000 ml beaker and a graduate cylinder
3. Stirring rod
4. Sample pans, 4-6 inch, with known tare weight
5. #50 standard sieve
6. Stopwatch or clock with second timer
7. Oven 110°C ± 5°C

PROCEDURE

1. Weigh to the nearest gram a 30 to 50 gram sample of fiber (air dry).
2. Mix thoroughly, using stirring rod, in 3,000 ml beaker with tap water equal to 50 times the sample weight, ± 50 ml, for 5 minutes (± 15 seconds).
3. After mixing, pour entire solution onto a #50 screen. It should mound up. Do not mould the sample. (See Photo A.)
4. Allow fiber to drain on the screen for 90 seconds (± seconds).
5. Carefully scoop by hand (see Photos B and C) a 200 to 500 gram sample from the mounded area. Weigh immediately including pan to ± .5 grams (wet weight). If sample is less than 200 or more than 500 grams, do not use. Start the test over from #1.
6. Oven dry at 110°C to constant weight. (Oven dry weight.) Weigh to ± .5 grams, including pan.

Precautions

1. The operator must remove the sample of saturated material from the drain screen as carefully as possible to prevent excess squeezing of water from the mulch. Refer to photographs of procedure.

2. The operator should take note of any equipment deficiencies such as plugged or torn screens. If these are observed during performance of the test the results should be discarded.

CALCULATIONS

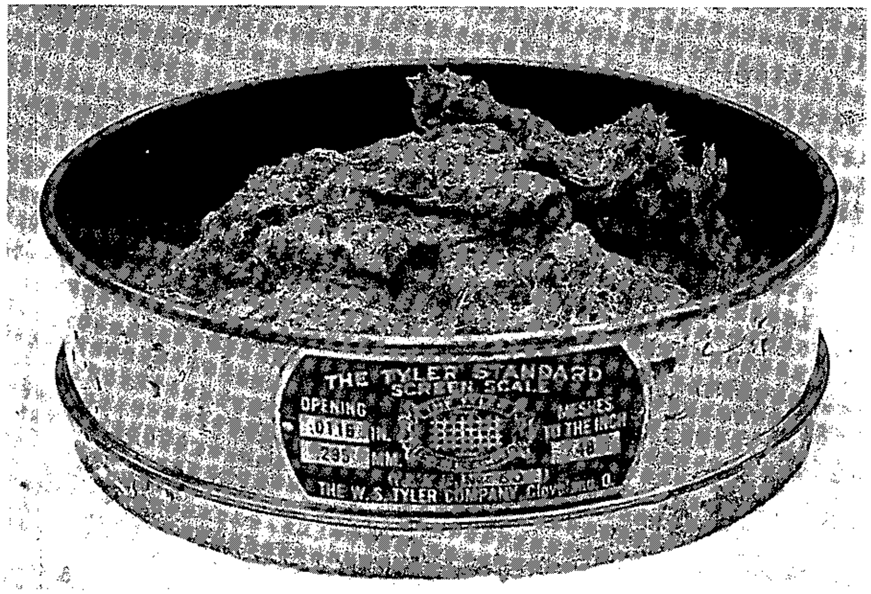
This test should be performed at least 3 times and the average value should be used to designate the water-holding capacity.

$$\text{Percent water-holding capacity} = \frac{(A-B)\,100}{C}$$

A = (wet weight 1 + wet weight 2 + wet weight 3)

B = (oven dry wt 1 + oven dry wt 2 + oven dry wt 3)

C = B-(tare wt 1 + tare wt 2 + tare wt 3)



A - Mounded fiber from pouring mixture onto screen.

B - First step in scooping sample from screen.

C - Sample, as scooped, ready to be put in pan for weighing and drying.

APPENDIX B

INITIAL TESTING PROCEDURE FOR WATER-HOLDING CAPACITY OF HYDROMULCH FIBER

Materials and Apparatus

1. Scale 0-1,000 grams ± .5 grams
2. 3,000 ml beaker and a graduate cylinder
3. Stirring rod
4. Sample pans, 4-6 inch, with known tare weight
5. #50 standard sieve
6. Stopwatch or closk with second timer
7. Oven 110°C ± 5°C

PROCEDURE

1. Take a 30-50 gram sample of fiber (air dry).

2. Mix thoroughly in 3,000 ml beaker with tap water equal to 50 times the sample weight for 5 minutes (± 15 seconds).

3. After mixing, pour entire solution onto a #50 screen. It should mound up.

4. Allow fiber to drain on the screen for 90 seconds ± 5 seconds).

5. Carefully scoop by hand a 250 gram (± 15 grams) sample from the mounded area. Weigh immediately to ± .5 grams (wet weight).

6. Oven dry to constant weight. (Oven dry weight.) Weigh to ± .5 grams.

CALCULATIONS

$$\text{Percent water-holding capacity} = \frac{100 \text{ x (wet weight - oven dry weight)}}{\text{(oven dry weight - tare weight)}}$$

APPENDIX C

ONE-WAY ANALYSIS OF VARIANCE

EXPERIMENT A - VARIABLE: SOAK TIME

TREATMENT	OBS	MEAN	VARIANCE	STD. DEV.
1(5 min.)	3	15.10000	1.00000	1.00000
2(10 ")	3	14.13333	3.80333	1.95021
3(20 ")	3	14.36667	.10333	.32146
4(30 ")	3	14.26667	.08333	.28868

GRAND MEAN = 14.4667

ANALYSIS OF VARIANCE TABLE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO
TREATMENTS	1.68667	3	.56222	.45068
RESIDUAL	9.98000	8	1.24750	
TOTAL	11.66667	11	1.06061	

DATA
WATER-HOLDING CAPACITIES (hundreds of percent)

	RUN 1	RUN 2	RUN 3
5 min.	15.1	16.1	14.1
10 "	12.2	14.1	16.1
20 "	14.0	14.6	14.5
30 "	14.1	14.1	14.6

All test runs were made by the same operator using silva fiber.

APPENDIX D

ONE-WAY ANALYSIS OF VARIANCE

EXPERIMENT B - VARIABLE: SOAK AND STIR TIME

TREATMENT	OBS	MEAN	VARIANCE	STD. DEV.
1(3 min.)	3	14.03333	.44333	.66583
2(5 ")	3	13.83333	.05333	.23094
3(7 ")	3	14.76667	1.33333	1.15470
4(10 ")	3	14.93333	1.08333	1.04083

GRAND MEAN = 14.3917

ANALYSIS OF VARIANCE TABLE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO
TREATMENTS	2.62250	3	.87417	1.20023
RESIDUAL	5.82667	8	.72833	
TOTAL	8.44917	11	.76811	

DATA
WATER HOLDING CAPACITIES (hundreds of percent)

	RUN 1	RUN 2	RUN 3
3 min.	14.2	13.3	14.6
5 "	14.1	13.7	13.7
7 "	14.1	16.1	14.1
10 "	16.1	14.6	14.1

All test runs were made by the same operator using silva fiber.

APPENDIX G

ONE-WAY ANALYSIS OF VARIANCE

WATERCAP SCOOPING VS SCREENING

TREATMENT	OBS	MEAN	VARIANCE	STD. DEV.
Scooping	9	15.63222	.07744	.27829
Screening	6	19.80333	20.73939	4.55405

GRAND MEAN = 17.3007

ANALYSIS OF VARIANCE TABLE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO
TREATMENTS	62.63339	1	62.63339	7.80542
RESIDUAL	104.31648	13	8.02434	
TOTAL	166.94987	14	11.92499	

DATA
WATER-HOLDING CAPACITIES (hundreds of percent)

	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6	RUN 7	RUN 8	RUN 9
Scooping	15.45	15.51	16.09	15.68	15.79	15.22	15.68	15.35	15.92
Screening	18.14	17.63	20.5	13.2	26.2	23.15			

All test runs were made by the same operator using silva fiber.

APPENDIX H

ONE-WAY ANALYSIS OF VARIANCE

MULCH TYPE VARIATION

MULCH TYPE	OBS	MEAN	VARIANCE	STD. DEV.
1	3	7.65333	.02083	.14434
2	3	10.54000	.00000	.00000
3	3	8.05667	.69463	.83345
4	3	4.54000	.17830	.42226
5	3	14.16000	.03880	.19698
6	3	14.29667	.18503	.43016
7	3	7.34000	.09970	.31575

GRAND MEAN = 9.51238

ANALYSIS OF VARIANCE TABLE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO
TREATMENTS	241.69420	6	40.28237	231.64099
RESIDUAL	2.43460	14	.17390	
TOTAL	244.12880	20	12.20644	

DATA
WATER-HOLDING CAPACITIES (hundreds of percent)

MULCH TYPE	RUN 1	RUN 2	RUN 3
SODIUM HYDROXIDE TREATED RYE STRAW	7.57	7.57	7.82
AGRIFIBER	10.54	10.54	10.54
"V" MULCH	8.38	7.11	8.68
JACKLIN ORGANIC MULCH	5.0	4.17	4.45
CONWED 2000	14.38	14.0	14.1
CONWED	14.10	14.79	14.0
SHREDDED PAPER	7.11	7.21	7.7

All test runs were made by the same operator.

APPENDIX E

ONE-WAY ANALYSIS OF VARIANCE

EXPERIMENT C - VARIABLE: DRAIN TIME

TREATMENT	OBS	MEAN	VARIANCE	STD. DEV.
1(60 sec.)	3	15.43333	.58333	.76376
2(90 ")	3	15.10000	1.00000	1.00000
3(120 ")	3	14.63333	.90333	.95044
4(180 ")	3	15.26667	1.08333	1.04083
5(300 ")	3	14.63333	.90333	.95044

GRAND MEAN = 15.0133

ANALYSIS OF VARIANCE TABLE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO
TREATMENTS	1.61067	4	.40267	.45007
RESIDUAL	8.94667	10	.89467	
TOTAL	10.55733	14	.75410	

DATA
WATER-HOLDING CAPACITIES (hundreds of percent)

	RUN 1	RUN 2	RUN 3
60 sec.	14.6	15.6	16.1
90 "	15.1	16.1	14.1
120 "	13.7	14.6	15.6
180 "	14.1	15.6	16.1
300 "	15.6	13.7	14.6

All test runs were made by the same operator using silva fiber.

APPENDIX F

ONE-WAY ANALYSIS OF VARIANCE

EXPERIMENT D - VARIABLE: DRYING TIME

TREATMENT	OBS	MEAN	VARIANCE	STD. DEV.
1 (4 hrs.)	3	11.30000	1.39000	1.17898
2 (8 ")	3	15.43333	.58333	.76376
3 (24 ")	6	15.76667	.83867	.91579

GRAND MEAN = 14.5667

ANALYSIS OF VARIANCE TABLE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO
TREATMENTS	42.90667	2	21.45333	23.71991
RESIDUAL	8.14000	9	.90444	
TOTAL	51.04667	11	4.64061	

DATA
WATER HOLDING CAPACITIES (hundreds of percent)

	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6
4 hrs.	10.0	12.3	11.6			
8 "	16.1	14.6	15.6			
24 "	15.0	16.1	15.0	15.1	17.3	16.1

All test runs were made by the same operator using silva fiber.

APPENDIX I

ONE-WAY ANALYSIS OF VARIANCE

WATERCAP OPERATORS VARY

OPERATOR	OBS	MEAN	VARIANCE	STD. DEV.
1	6	15.45167	.15726	.39656
2	3	15.50667	1.03085	1.01530
3	7	16.09143	.44025	.66351
4	6	15.68000	.04204	.20504
5	4	15.79250	.03736	.19328
6	7	15.22000	.02430	.15588
7	7	15.67714	.17189	.41460
8	3	15.35333	.55043	.74191
9	3	15.92333	.06263	.25027

GRAND MEAN = 15.6354

ANALYSIS OF VARIANCE TABLE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO
TREATMENTS	3.52616	8	.44077	1.98521
RESIDUAL	8.21499	37	.22203	
TOTAL	11.74115	45	.26091	

DATA
WATER-HOLDING CAPACITIES (hundreds of percent)

OPERATOR	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6	RUN 7
1	15.64	15.87	15.47	14.7	15.55	15.48	
2	14.34	16.19	15.99				
3	14.68	16.1	16.11	16.63	16.52	16.51	16.09
4	16.0	15.62	15.67	15.82	15.42	15.55	
5	15.52	15.79	15.93	15.93			
6	15.03	15.22	15.2	15.48	15.08	15.17	15.36
7	15.5	15.48	15.0	15.79	16.2	15.63	16.14
8	14.53	15.56	15.97				
9	16.18	15.68	15.91				

All runs were with silva fiber.