[redacted]

23 February 1938

NRL Report No. P-1426

FR-1426

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report
on

The Suitability of Rubatex and Chlorinated Rubber as a Flotation Material.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 7 Plates - 2

Authorization: Bu. C&R ltr. JJ/Rubber-(3)(RI) of Nov. 26, 1937.

Date of Test: December 20, 1937 to February 17, 1938.

Work Performed by: Wayne Hall, Contract Employee

J. C. White, Asst. Chemist.

Prepared by: J. C. WHITE, Asst. Chemist.

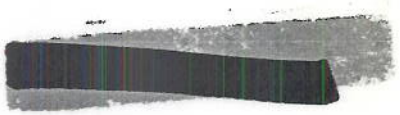
Reviewed by: P. Borgstrom, Chemist, Supt., Chemistry Division.

Approved by: H. M. Cooley, Captain, USN., Director.

Distribution:
Bu.C&R (5)

TABLE OF CONTENTS

APPENDICES



ABSTRACT

Studies have been conducted on two forms of gasified rubber to determine: (a) Water Absorption, (b) Compressibility, (c) Corrosion Activity. The purpose of the studies was to obtain information bearing on the suitability of these compositions as flotation materials.

It has been determined that Rubatex provided with a hard unpunctured skin is relatively impervious to water absorption, is fairly resistant to compressive loads and does not appear to promote corrosion. If the protective coating of this material is broken or removed, the water absorption is considerable; the material is permanently deformed by compressive loads, but corrosion is not accelerated.

By comparative tests it was determined that the chlorinated rubber material was less resistant to water absorption, that it had less compression resistance, was fragile and required considerable care in handling. Insufficient material was available for corrosion tests but it was determined that hydrogen chloride gas was only evolved at elevated temperatures.

INTRODUCTION

(a) Authorization

1. This test was authorized by Bureau of Construction and Repair letter JJ/Rubber-(3)(RI) of Nov. 26, 1937.

(b) Object of Test

2. The object of this test is to investigate the suitability of Rubatex and chlorinated rubber as flotation material.

EXPERIMENTAL PROCEDURE

Methods

(a) Description of the Materials under Test

3. The Rubatex material was in the form of blocks about 19 cm x 15 cm x 5 cm. Some of these blocks were covered only with the material itself and the others had a covering of cellophane. One block of the former had been painted with asbestos paint.

4. The chlorinated rubber material was in tubular form about 3.5 cm in diameter and in various lengths. The open ends were sealed with Picein wax.

(b) Description of the Experiments

5. Water Absorption. The amount of water absorbed by the material was determined after being exposed to the following conditions: (a) 24 hours to a relative humidity of 30% at 90°F.; (b) 72 hours to a relative humidity of 100% at 90°F; and (c) 24 hours submerged in water at room temperature.

6. Compressibility. Hydrostatic pressure up to about 8 pounds per square inch in water was applied to each of the materials. Since there was considerable time lag in the volume changes under pressure the measurements were made at equal time intervals.

7. Corrosion Activity. Two steel boxes were pickeled in an acid bath, carefully rinsed with water and half-filled with a 4% salt solution. The Rubatex material was then submerged in one of these boxes. Both boxes were covered and placed in a thermostat set at 100°F. At various intervals the two boxes were examined for visual effects of corrosion. After 27 days samples of the solution in each box were removed. The PH and the iron content of each solution was then determined. The density of the material after being submerged for 27 days was also determined. This procedure was repeated at the end of 56 days.

8. Strength Test of Chlorinated Rubber Material. (a) A 4-1/4" length of the tubular material was clamped in a horizontal position with a bearing of 1" in the support. An upward or downward force could be applied to the other end of the material by means of a 1-1/4" wood collar. This left a distance of 2" between the stationary end and the collar. Starting with a load of 2 pounds a downward force was exerted for 30 seconds and then

an upward force for 30 seconds. This was repeated until 5 forces in each direction had been applied. The procedure was then repeated for loads of 3, 4, 5, 6, 7 and 8 pounds.

(b) A 1-3/4" length of the material was placed on a large scale and pressure applied to it by means of a strip of wood which covered its entire length. The weight at which the material was crushed was then determined.

(c) A 2" piece of the material was placed on the floor and another 2" piece placed across it. With a load of 8 pounds on the latter the lower piece was rolled back and forth until the material broke.

9. Inflammability. The ease of ignition of the various materials was determined by placing them in the flame of a bunsen burner. The gases evolved were identified.

RESULTS

Data Obtained

10. Water Absorption. The results of this test are shwon in the table. The densities are given in the last column.

		Percentage change from original weight			
Number of Material	Original weight	24 hrs.90°F 30% humidity	72 hrs.90°F 100% hum.	24 hrs.submerged in water room temp.	Density Water = 1
1	108.403	-0.0397	+0.0341	+0.0378	0.0756
2	108.315	-0.0369	+0.0378	-	-
3	114.226	-0.0288	+0.234	+0.257	0.0775
4	66.651	-0.703	-1.046	+16.45	0.0495
5	26.299	-0.0114	+0.437	+6.77	0.172
6	24.316	-0.0082	+0.366	+9.63	-
7	13.480	-	-	+10.53	0.106
8	17.994	-	-	+8.78	-
9	125.860	-0.0827	+0.524	+58.1	0.0745
10	115.593	-0.0286	+0.539	+55.8	-

No. 1 and 2 were the Rubatex material with cellophane covering.
No. 3 was the Rubatex material without the cellophane covering.
No. 4 was No. 2 with the outside covering of cellophane and the outer layer of the material itself removed.
No. 5 and 6 were the chlorinated rubber with the ends covered with Picein wax. The value given for its density has been corrected for the weight of the wax.
No. 7 was No. 5 with the outer covering and waxed ends removed.
No. 8 was No. 6 with the waxed ends removed.
No. 9 and 10 were the Rubatex material without the cellophane covering but painted with asbestos paint. An attempt to cover the open ends of these blocks with label varnish was unsuccessful.

11. Compressibility. The results of the four tests conducted are given in the table below:

Test Number	1	2	3	4
Type of Material	Rubatex	Rubatex	Rubatex	Chlorinated Rubber
*Material Numbers	1,2,3,4	1,3,4,5	3,4,6	1,2
Maximum pressure applied lbs/sq.in.	5.9	7.9	8.4	8.4
Average compressibility in percent per lb/sq.in.	0.4	0.35	0.2	0.6
Residual decrease in volume after 2 pressure cycles	(1 cycle) 1%	2.%	0.2%	6%
Gain in weight during test	No.2 0.5%	No.5 39%	No gain	No. 2 85%
Visible deformation after removing pressure	No. 1 & 2 permanent	No. 1 & 5 permanent	None	None
Remarks		Water entered thru a defect in No. 5		Water entered thru a hole in Picein in No. 2

* No. 1, 2 and 5 of the Rubatex material were of the uncovered blocks.
No. 3, 4 and 6 of the Rubatex material were the cellophane covered blocks.

The compressibility curve for test No. 3 is shown by Plate 1 and for Test No. 4, by Plate 2.

12. Corrosion activity of Rubatex. A block of the uncovered material was used in this test. No visual difference could be detected in corrosion of the two steel boxes at any time during the 56 days that the test has been conducted. The pH's of the two solution at the end of 27 days and at the end of 56 days were determined. The pH of a 4% salt solution is given for comparison.

Solution	pH 27 days	pH 56 days
4% salt solution	7.41	
From control box	7.2	8.7
From test box	5.9	7.6

The total iron in solution and in suspension was determined in 50 cc samples taken from each box at the end of 27 days and at the end of 56 days. The solutions in the boxes were well stirred before the samples were removed.

Total iron in 50 cc samples in grams.

	27 days	56 days
Control	0.085	0.207
Test	0.071	0.203

The density of the block after being submerged for 56 days in a 4% salt solution was 0.076.

13. Strength of chlorinated rubber.

(a) In this test, with a 2" length of the material between the supported end and the end to which the upward or downward force was applied, it required a force of 8 pounds to break the material. It stood the first downward force of 8 pounds but broke on the first upward force of 8 pounds.

(b) The 1-3/4" length of material cracked slightly at a load of 12 pounds and at 27 pounds it suddenly became completely crushed.

(c) The two 2" lengths when rolled back and forth across each other under a load of 8 pounds were crushed after about 7 back and forth motions.

As soon as the outer covering is broken there is very little resistance to crushing. The inner material is easily crushed between the fingers.

14. Inflammability. (a) The Rubatex material is very easily ignited by a flame and it continues to burn vigorously after the flame has been removed. Large quantities of black smoke are evolved when the material burns. The Rubertex material which has been painted with asbestos paint was ignited only after it had been in contact with a flame for a much longer time. It did not continue to burn after the flame was removed unless the covering of asbestos paint has been burned off.

(b) The chlorinated rubber burns only when held directly in a very hot flame. It will not burn after the flame has been removed. When it does burn large amounts of hydrogen chloride gas are evolved.

15. Evolution of Hydrogen Sulphide Gas from Rubatex. Hydrogen sulphide gas could be detected by its odor when the closed vessels in which the water absorption tests were conducted were opened after containing the Rubatex material. This was particularly noticeable in the case of the block from which all outside covering had been removed. This was true of all the Rubatex material except the piece that had been painted with asbestos paint and from which No. 9 and 10 had been cut. Information received with this material indicated that it had been cured for several months before it had been shipped.

DISCUSSION OF TESULTS

16. Water Absorption. The Rubatex material when properly covered absorbs less than 0.04% water under the conditions of the test. As shown by the results of No. 3 and by the density of the material used in the corrosion test after being submerged in a 4% salt solution for 27 days the cellophane covering is not essential but it does insure against any defects that may be present in the outer layers of the block itself. In each case where there was a defect in the outer layers or when the cellophane covering had been removed large amounts of water were absorbed.

17. The loss in weight of No. 4 when exposed to a relative humidity of 100% was probably due to its loss of hydrogen sulphide. This loss of hydrogen sulphide was greatly accelerated by the removal of the cellophane covering and the outer layer of the material itself.

18. The covering on the chlorinated Rubber does not prevent the absorption of water when the material is submerged in water. When exposed to an atmosphere of 100% relative humidity it absorbs about ten times as much water as the Rubatex material.

19. Compressibility. The compressibility of the cellophane covered Rubatex material is about one-half that of the uncovered material. The latter is permanently deformed after being subjected to a hydrostatic pressure while the former was not affected.

20. The compressibility of the chlorinated Rubber material is about three times that of the cellophane covered Rubatex material.

21. Corrosion activity of Rubatex. During the period that the test has been conducted Rubatex does not promote any visual effects of corrosion on steel in a 4% salt solution. The hydrogen ion concentration increased slightly in the test solution at the end of 27 days but at the end of 56 days it was very close to the pH of a 4% salt solution. The control solution increased very little in hydrogen ion conventration during the first 27 days and at the end of 56 days it had decreased by about the same amount as the test solution over the same period of time. The amount of iron in the 50 cc samples at the end of 27 days was considerably lower in the test solution, but at the end of 56 days practically the same amount was present in both solutions.

22. In a period of about 2 months Rubatex has no appreciable corrosion activity on steel in a 4% salt solution.

23. Strength of Chlorinated Rubber. This series of tests indicate the tubular material is quite fragile and that considerable care must be exercised in its handling. This is due to its brittle-like structure and its tendency to be crushed rather than to give when pressure is applied.

24. Inflammability. By painting the Rubatex material with asbestos paint its inflammability is considerably reduced but the fire hazard is not entirely removed.

25. The chlorinated rubber would not be considered as a fire hazard in itself, but if it were in a hot fire large amounts of hydrogen chloride gas would be evolved. This would make the fire difficult to combat unless gas masks capable of absorbing large quantities of acid fumes were available.

26. Evolution of Hydrogen Sulphide Gas from Rubatex. The evolution of hydrogen sulphide gas from the Rubatex material would make it dangerous to store the material in a closed place. This gas is very poisonous. It can easily be detected by its odor when present in one part in 70,000 but if the concentration is over 0.01% its characteristic odor is less distinct. Thus if the concentration is greater than 0.01% it would be difficult to detect and one would not be aware of its danger. This difficulty could be overcome by allowing the material to be stored in a well ventilated place until the gas could no longer be detected. This would best be done before the outside covering had been put on in order to permit an easier escape of the gas. Evidence to support this procedure is given by the fact that no hydrogen sulphide was detected from the Rubatex material that had been painted with asbestos paint. This material had been cured for several months, before it had been received by the Laboratory.

27. Density. The density of the Chlorinated Rubber is about 80% that of cork and the density of the Rubatex is about 44% that of the Chlorinated Rubber. As a means of comparison the density of water, cork, chlorinated Rubber and Rubatex are given

H_2O	1.00
Cork	0.22
Chlorinated Rubber	0.172
Rubatex	0.076

CONCLUSIONS

28. Less than 0.04% water is absorbed by the cellophane covered Rubatex material when submerged in water for 24 hours. The uncovered Rubatex material absorbs very little more if it is perfectly sealed.

29. The Chlorinated Rubber absorbs about 0.4% water when exposed to 100% relative humidity at 90°F for 72 hours. It absorbs between 8 and 10% water when submerged for 24 hours in water.

30. The compressibility of the cellophane covered Rubatex material is about 0.2% per pound per sq.in. For the uncovered Rubatex material it is about 0.4% and for the chlorinated rubber about 0.6%. The uncovered Rubatex material is permanently deformed.

31. The Rubatex material does not promote the corrosion of steel in a 4% salt solution over a period of 56 days.

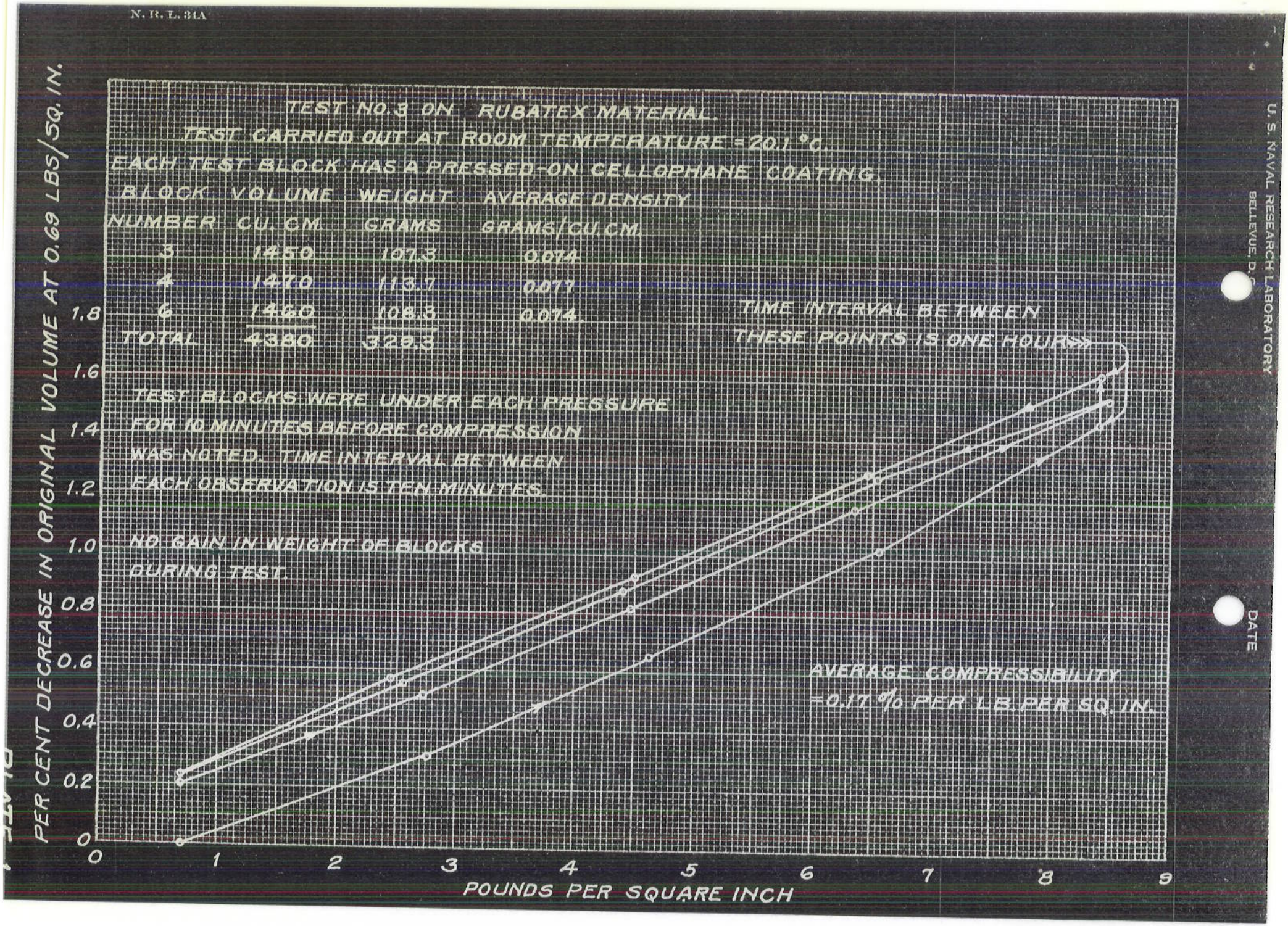
32. The Chlorinated Rubber is fragile and has a brittle-like structure. It must be handled with a great deal of care.

33. The inflammability of the Rubatex material is high but is reduced to a large extent by painting with asbestos paint. The chlorinated rubber is ignited only by a hot flame, but when it burns considerable quantities of hydrogen chloride gas are evolved.

34. The Rubatex material gives off considerable quantities of hydrogen sulphide gas, but if allowed to stand for some time the gas will practically all excape.

35. The density of the Rubatex material is 0.076 and the Chlorinated Rubber .172 compared with water as 1.00.

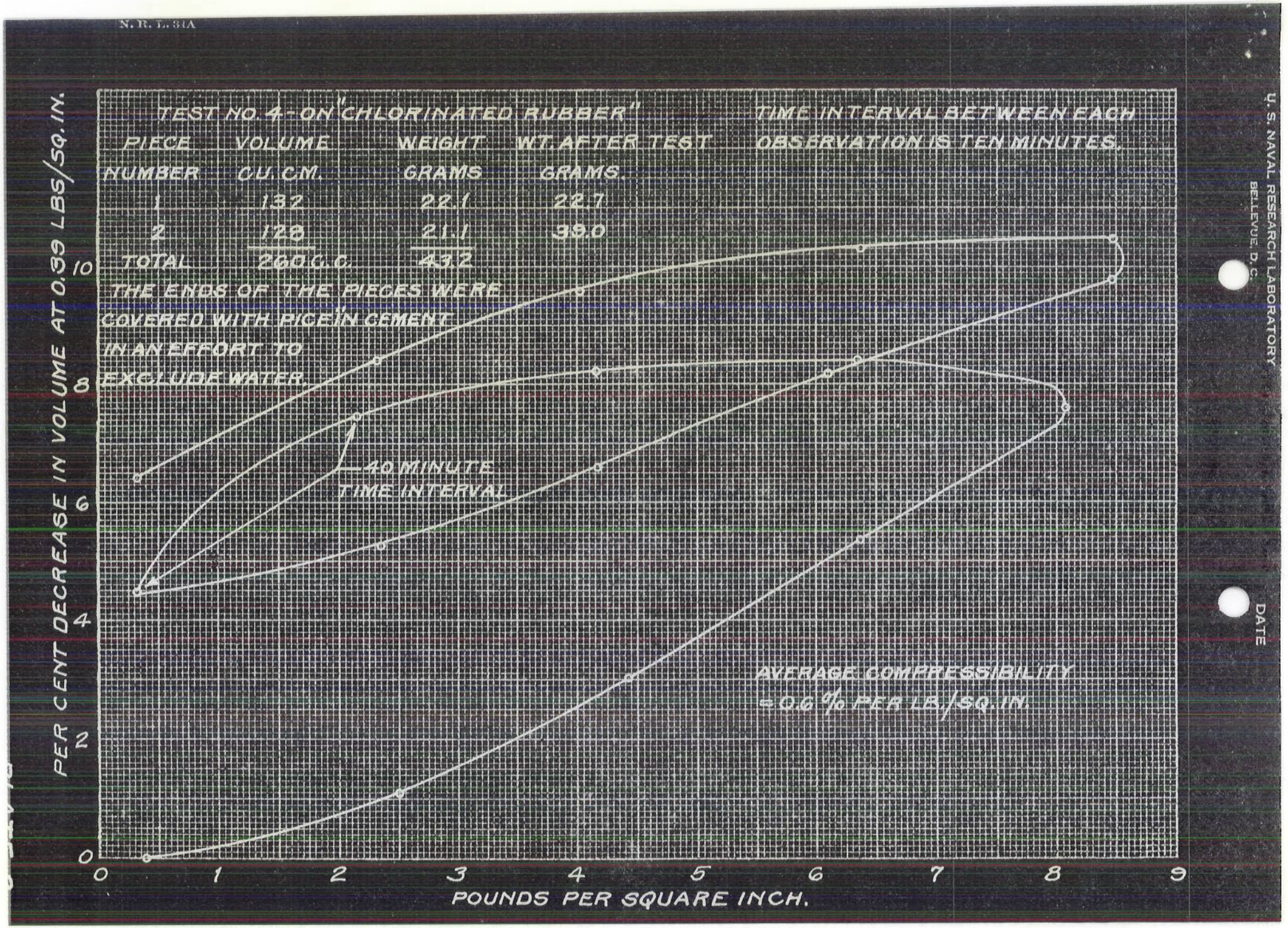
N. R. L. 31A



U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

N.R.L. 31A



U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE